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THE SERVICE OF MEDICINE TO CIVILIZATION[1]

Fellow Members of the American Medical Association: I wish to express my appreciation of the honor conferred on me in being called to officiate as your president at this time. I had been content to serve in the ranks, and I have regarded this position as too honorable to be sought, or to be lightly regarded when spontaneously bestowed. During my term of office I will give you my most devoted service.

In ancient times, civilization was born, grew for a few generations and fell into decay. In all instances it was local and covered only small areas. Its habitations were oases in the world-wide desert of ignorance and superstition, and after an ephemeral existence all were buried in the sand. Relatively small bodies of men occupying salubrious regions developed the elements of science and for a few centuries flourished. Their superior knowledge gave them dominion over their less fortunate neighbors, who were converted into slaves. Conquest brought disease and the local civilizations were obliterated by contagion. History is replete with instances in which triumphant heroes have brought to their rejoicing countries with their prisoners of war invisible and intangible agents of death, which have ultimately vanquished the victors.

The Egyptians of the Pharaohs drained the land, built aqueducts, disposed of their dead hygienically, reared temples and cities, maintained law and order, developed

[1] President's address before the American Medical Association, at the sixty-fifth annual session, Atlantic City, June, 1914.

the elements of literature and science and devised and employed simple machinery. In speaking of the ancient Egyptians, Diodorus says:

> The whole manner of life was so evenly ordered that it would appear as though it had been arranged by a learned physician, rather than by a lawgiver.

Herodotus declared ancient Egypt the healthiest of countries, but filled with physicians of whom

> one treats only the diseases of the eye, another those of the head, the teeth, the abdomen or the internal organs.

Writing of a later time, Gibbon said:

> Ethiopia and Egypt have been stigmatized in all ages as the original source and seminary of the plague.

It is evident that in the time of its great civilization Egypt was salubrious; coincident with the decline in the learning and wisdom of its people, it was visited and desolated by pestilence. That Egypt had lost its salubrity as early as the period of the exodus of the Israelites is shown by many passages in the Bible in which the chosen people are threatened with the diseases of Egypt if they neglect or violate the laws. Moses, "learned in all the wisdom of the Egyptians," codified his sanitary rules and regulations in the form of religious rites and ceremonies and thus secured their observance among the faithful even down to the present time.[2]

The Greek developed the most glorious civilization of antiquity because he was the most ardent student of science, but he was unable to cope with malaria and bubonic plague, and his descendants have been in bondage to malaria for nearly twenty-four centuries. The medicine of Hippocrates, the wisdom of Socrates, the philosophy of Plato, the plays of Aristophanes, the laws of Pericles and the science of Aristotle could not save the Greek from the degrading effects of disease, and under its withering influence the civilization of this great people slowly but surely decayed. Its matchless marbles were thrown into the waste, its magnificent temples were allowed to crumble, its altars were deserted, its literature became insipid, its philosophy lost its virility, its science was forgotten and the children of this blighted civilization were sold in the slave markets of Rome and in later generations paid tribute to the Slav and the Turk. There certainly were eminent Greek scientists and physicians for centuries after Hippocrates, but they were not products of Greek soil. They developed in Asia Minor, Egypt, Italy and elsewhere. It is of interest to note in this connection that malaria, according to Jones, was introduced into Greece in the fifth century, B.C., and the fourth century showed the decline of Hippocratic medicine. Neuburger says:

> The sons and grandsons of Hippocrates, as well as his immediate disciples, Apollonios and Dexippos, were at the head of that series of physicians who laid emphasis upon theoretical conjecture and gave to medicine in the fourth century B.C. its speculative coloring.

Taken with the fact that other departments of learning showed similar retrogression at the same time, this sequence between the introduction of malaria and the trend of medicine toward speculation is worthy of record. That pestilence aided the barbarians in the final desolation of Greece is indicated by the following quotation from Thumb:

[2] Neither the papyrus of Ebers nor that of Brugsch throws any light on the problems discussed in this article. Indeed the value of both these papyri was at first overestimated. They are now regarded as compilations and consist largely of lists of remedies and furnish no information concerning epidemics or their effects upon the people, except to indicate that hookworm or bilharzia infection, one or both, at that time (about 1500 B.C.) afflicted the Egyptians. These parasites may have contributed to the deterioration of the people; this is a suggestive possibility.

At a time when the German tribes began moving, that is to say, at the end of the third century A.D., a gradual immigration of Slavonic tribes into the Balkans began; their invasions became more and more frequent, since the Goths chose Western Europe as the goal of their conquering expeditions and left to the Slavs an open passage into the Balkan countries. But a real Slavonization of some Greek territories took place only in the eighth century, and attained its highest point when a horrible plague in 746 depopulated the Greek territories.

I am aware of the fact that some have objected to considering the present inhabitants of Greece as descendants of ancient Greeks. The former have been designated as "so-called Greeks," "a bastard people," "a mosaic of Vlacks, Arnauts and Slavs." Some years ago Fallmerayer made the very positive statement that "no drop of ancient Greek blood flows in the veins of the modern Greek." Thumb has shown the absurdity of these statements and declares that cranial measurements, local names, customs and religion show that while some admixture with the Slav has taken place, the modern Greek is a lineal, and on the whole a fairly pure descendant of those who established the greatest civilization of antiquity. Modern Greek Christianity is only a modification of ancient Greek paganism, in which gods have been supplanted by saints.

Charon the old ferry-man in the underworld is to-day the god of death; he conducts the souls in a dreary procession to his realm. As in antiquity, a copper coin is put into the mouth of a dead person as a fee for the ferry into the other world. The ancient Moirai or fates (to-day, Mires) still determine the fate of the new-born child, spin and cut the thread of life. The bride is conducted into her new home, the dead are buried with ceremonies which the Greeks used already two thousand years ago. A sick person seeks recovery by laying down to sleep in the church of a saint, like those persons who once made a pilgrimage to the temple of Asklepios in Epidaurus. The Greeks of to-day are descendants of the ancient Hellenes, not in the sense in which every modern Greek could trace his origin back to an ancient Athenian or Spartan, but in the sense that in the modern people ancient blood flows largely and in some districts almost purely, and still more in the higher sense that the modern race shows a development of the Greek population of the ancient world.

The broken remnants of older civilizations found refuge and asylum in the salubrious climate of the Italian peninsula and soon its hillsides were covered with vines and olives while its plains and valleys bore abundant harvests. Rome was built and her empire promised to extend to the remotest parts of the world, but the ancient Roman contributed but little to science, and we are told by the historian that

a pestilence raged for fifteen years (251–265) and carried off one half of the inhabitants of the empire.

The seat of civilization was moved to the shore of the Bosphorus, but the lamp of science was well-nigh extinguished and the clouds of the middle ages enveloped the world and shrouded its inhabitants for more than a thousand years.

A fabulous and formless darkness overcame the fairest things of earth.

If one reads the history of the decline of the Roman Empire, he can hardly fail to see that disease was an important factor in that retrograde movement, which involved the greater part of the then known world. Jones and Ross find the earliest reference to malaria among the Romans in the comedian Plautus, who died 184 B.C., and they quote Terence, who died 159 B.C., and whose language is explicit in showing not only the prevalence of malaria, but also the recognition of the different forms. From that time on, reference to the wide prevalence of malarial diseases, not only in the open country, but also in the city, is frequent and definite. Jones says:

There is then, every reason for supposing that malaria was unknown in Italy in early times, was well known at the beginning of the second century

B.C., and that it gradually became more common during the next two hundred years. If this be so, it is at least a plausible conjecture that it was introduced by Hannibal's Carthaginian mercenaries. Africa seems to have been the original home of the disease, and it is probable that some of his troops were infected. The constantly repeated devastation of Italy in the second Punic war should be sure to turn a large part of it into marshy land, thus affording a convenient breeding-place to the mosquitoes which were infected by the malarial patients among the Carthaginians. The similar condition of Attica during the closing years of the fifth century B.C. offers a striking parallel. This opinion does not rest on mere conjecture. We are told by Livy that in the year 208 B.C. a severe epidemic attacked Italy. It did not cause many deaths, but resulted in much lingering disease, that is, most probably, chronic malaria.

Malaria, however, was not the only disease which contributed to the degeneration of the Roman people. I have already referred to the pestilence of the third century, which is said to have destroyed half the inhabitants of the vast empire within fifteen years. This certainly was not malaria. Moreover, this was not the first great pestilence which afflicted the Roman Empire. Neuburger says:

The "plague," so called by Galen or Antonine, was first introduced from Syria by the Roman army. . . . The extraordinary contagiousness of the epidemic is emphasized in all contemporary reports. There appear to have been a variety of simultaneous manifestations, the descriptions indicating afflictions chiefly resembling small-pox or dysentery, but adequate criteria on which to express an opinion are wanting. The "plague" commenced 165 A.D., claimed innumerable victims and lasted at least fifteen years.

Jerome writes: With peace, order and good government a curious lethargy fell on the warrior state deepening into a coma in which it died so quietly that neither the contemporaries nor we moderns can fix the date of the disease. The fact, however, finally became apparent when the phenomena of decay were indubitable and the world, deprived of the master, fell back helplessly into a condition hardly more advanced than in the ages before its subjection, save that it had the imperishable memory of Rome to give it hope, direction and courage.

In the fourth century the seat of government was removed to Byzantium. It is probable that this change was, in part at least, determined by the insalubrity of Italy. Early in the fifth century Rome was pillaged, but the real conquerors of Rome were not the Goth and Vandals, but malaria and the plague. Disease continued to devastate Italy. Creighton says:

About the year 668 the English archbishop-elect, Vighard, having come to Rome to get his election confirmed by the pope, Vitalanius, was soon after his arrival cut off by the pestilence with almost all who had gone with him. Twelve years after, in 680, there was another severe pestilence in the months of July, August and September, causing a great mortality at Rome and such a panic at Pavia that the inhabitants fled to the mountains. In 746 a pestilence is said to have advanced from Sicily and Calabria and to have made such devastation in Rome that there were houses without a single inhabitant left.

From that time on the plague periodically spread over Italy until the seventeenth century, while malaria has been in continuous possession down to our own time. We are told that the epidemic of 1348 reduced the inhabitants of the Eternal City to 20,000.

We are familiar with the graphic description of the plague in Florence by Boccaccio, who wrote:

Such was the cruelty of Heaven, and perhaps of men, that between March and July following, it is supposed, and made pretty certain, that upwards of a hundred thousand souls perished in the city only, whereas, before that calamity, it was not supposed to have contained so many inhabitants. What magnificent dwellings, what noble palaces were then depopulated to the last person, what families extinct, what riches and vast possessions left, and no known heir to inherit, what numbers of both sexes in the prime and vigor of youth—whom in the morning neither Galen, Hippocrates nor Esculapius himself, but would have declared in perfect health—after dining heartily with their friends here, have supped with their departed friends in the other world.

There are but few passages in literature so tragic as the short record of the plague

of the fourteenth century begun by the friar of Kilkenny, but soon interupted by his death:

I friar, John Clyn, of the order of Friars Minor and of the convent of Kilkenny, wrote in this book those notable things which happened in my times, which I saw with my eyes, or which I learned from persons worthy of credit. And lest these things worthy of remembrance should perish with time and fall away from the memory of those who are to come after us, I, seeing these many evils, and the whole world lying, as it were in the wicked one, *among the dead, awaiting death*—as I have truly heard and examined, so have I reduced these things to writing; and lest the writing should perish with the writer, and the work fail altogether with the workman, I leave parchment for continuing the work, if haply, any man survive, and any of the race of Adam escape this pestilence and continue the work I have commenced.

That the period of the Byzantine Empire (395–1453) was one of general degeneracy is shown on every page of the historian. It produced no literature of merit, and "the study of nature was regarded as the surest symptom of an unbelieving mind." Neuburger says:

The Byzantines merely followed the downward path. Surfeited with tradition, which made modes of thought appear inevitable, because customary, filled as a nation with overweening self-conceit, fed by the glories of the Græco-Roman past, they neither could nor would destroy the historic bridge nor replace the crumbling ruin with a new edifice. It lay outside the sphere of their interests to enter into that conscious emulation of antiquity which, emphasizing the growing contrast between past and present, and eliminating the obsolete and the inert, is the essence of mental cultivation. Forgetting that it was the free development of the national spirit which constituted the greatness of the past, they went so far as to smother its liveliest expression by denying, in their rigid adherence to Attic speech, all part in literature to the language of the people. The more incapable did the Byzantines become of grasping the spirit, the more tenaciously did they cling to the letter—a reflection of the mania for titles and ceremonies in political life—and thus they dragged the inanimate mechanism, the dry bones of antiquity through a thousand years, instead of erecting a new edifice on the foundations of antiquity.

The physician and historian, Procopius, in his account of the great pestilence in the reign of Justinian "emulated the skill and diligence of Thucydides in the description of the plague at Athens." Of this epidemic Gibbon says:

In time its first malignancy was abated and dispersed; the disease alternately languished and revived; but it was not till the end of a calamitous period of fifty-two years, that mankind recovered their health, and the air resumed its pure and salubrious quality. No facts have been preserved to sustain an account, or even a conjecture, of the numbers that perished in this extraordinary mortality. I only find that during three months, four and at length ten thousand persons died each day at Constantinople, that many cities of the east were left vacant, and that in several districts of Italy, the harvest and the vintage withered on the ground. The triple scourge of war, pestilence and famine afflicted the subjects of Justinian, and his reign is disgraced by a visible decrease of the human species, which has never been replaced in some of the fairest countries of the globe.

This epidemic spread over the whole of Europe and it took more than a century to reach England, where "it fabled long after in prose and verse as the great plague of Cadwallader's time." Then for quite a thousand years it reaped its periodic harvests as often as immunity was lost in new generations.

The historian, as a rule, confines his descriptions to martial and political events and consequently gives a wholly erroneous idea of true conditions. Gibbon says:

If a man were called upon to fix the period in the history of the world, during which the condition of the human race was most happy and prosperous, he would without hesitation, name that which elapsed from the death of Domitian to the accession of Commodus (from 96 to 180 A.D.).

Noah Webster, in his work on epidemics and pestilence, quotes the preceding with the following just comment:

It is certain that, at this time, the Roman Empire was in its glory, and governed by a series of able and virtuous princes, who made the happiness

of their subjects their principal object. But the coloring given to the happiness of this period is far too brilliant. The success of armies and the extent of empire do not constitute exclusively the happiness of nations; and no historian has a title to the character of fidelity, who does not comprehend, in his general description of the state of mankind, moral and physical, as well as political evils.

Let us make brief inquiry into the diseases of this "most happy and prosperous" period. It was preceded by, it began in, continued in, and closed in pestilence. That the plague was endemic in Italy at that time and that it developed in epidemic form with each increase in susceptible material there can be no doubt. Of the epidemic of 68 A.D. Tacitus says:

Houses were filled with dead bodies and the streets with funerals; neither age nor sex was exempt; slaves and plebeians were suddenly taken off, amidst the lamentations of their wives and children, who, while they assisted the sick, or mourned the dead, were seized with the disease, and perishing, were burned on the same funeral pyre. To the knights and senators the disease was less mortal, though these also suffered in the common calamity.

About this time the plague appears to have spread over the whole of Asia, northern Africa and Europe. According to Short, the deaths from this disease in Scotland between 88 and 92 A.D. amounted to not less than 150,000. This was probably not less than one fourth, possibly one half, the population of Scotland at that time.

In the year 80 A.D. the deaths from the plague in Rome at the height of the epidemic numbered 10,000 a day. It is estimated that the population of Rome at that time was somewhat more than one million. Exacerbations of the disease in Rome are recorded for the years 102, 107 and 117 A.D. According to Short, 45,000 died of the plague in Wales in 114. The year 167 A.D. is noted for an unusually severe outbreak of the plague at Rome, where it continued for many years. In the year 173 A.D., the Roman army was threatened with extinction by disease, and special epidemics, or rather exacerbations of the epidemic, prevailed in Rome in 175 and 178 A.D. That the "happy and prosperous" period was followed by a continuation of the plague is shown by the following quotation from Herodian:

A great pestilence raged throughout Italy at that time (about 187 A.D.), but with most violence in the city, by reason of the great concourse of people assembled from all parts of the earth. The mortality among men and cattle was great. The Emperor, by advice of physicians, retired to Laurentium, on account of the coolness of the place, which was shaded with laurels. It was supposed that the fragrance of the laurels acted as an antidote against the contagion. The people in the city also, by the advice of physicians, filled their noses and ears with sweet ointments and used perfumes, etc.

Under the spell of the historian we have been inclined to regard the period when the greater philosopher, Marcus Aurelius Antoninus, sat on the throne of the world, as the golden age. Let us therefore listen to a few words from his personal attendant, courtier and historian, who writes:

Unless he, M. Antoninus, had been born at this juncture, the affairs of the empire would have fallen into speedy ruin; for there was no respite from military operations. War raged in the east, in Illyricum, in Italy and in Gaul. Earthquakes with the destruction of cities, inundations of rivers, frequent plagues, a species of locusts ravaging the fields; in short every calamity that can be conceived to afflict and torment man scourged the human race during his administration.

It is estimated that during the dark ages the average of human life was less than twenty years. A high birth-rate was necessary to keep the race alive, but notwithstanding this, Europe was sparsely inhabited. At the time of the Norman Conquest the inhabitants of England numbered between two and two and one half million, probably nearer the former, for they had

not reached the greater number a hundred years later. Creighton says:

It would be within the mark to say that less than one tenth of the population was urban in any distinctive sense of the term. After London, Norwick, York and Lincoln, there were probably no towns with five thousand inhabitants.

Indeed, urban life, as we now know it, was quite impossible in this age of pestilence and would soon become so again were the functions of preventive medicine relaxed.

Most of the great epidemics of the middle ages were designated as *pestilentia* or *magna mortalitas.* In the most deadly visitations the bubonic plague is so accurately described that there can be no doubt about its identity, but it must not be supposed that the people enjoyed any high degree of health even in those periods when this contagion languished on account of exhaustion of susceptible victims. Ergotism, under the name of Saint Anthony's fire, was endemic in France and adjacent territories; Normandy was filled with lepers, but Christ's poor were not confined to that country. England was regarded as the special home of hunger, but abundance was a stranger to the masses in every land. The mysterious sweating sickness, apparently brought to England with Henry Tudor in 1485, developed in five distinct epidemics which were characterized by the fact that the mortality was greater among the rich than among the poor. Typhus, known as *morbus pauperum,* prevailed largely in the jails, on ships and among the squalid inhabitants of the cities. Even the discovery of America carried to Europe the scourge of syphilis, which was spread over Italy by the soldiers of Charles VIII., and within a few years reached the most distant parts of Europe. Smallpox appeared in England in the sixteenth century, having journeyed, according to the most reliable authority, all the way from the Orient. That tuberculosis, diphtheria, dysentery and other diseases, still with us, prevailed during the middle ages is shown by the records, but they were overshadowed by the higher mortality of those mentioned above. Improved agriculture has extinguished the fire of St. Anthony, except in the most benighted provinces of Russia. The great fire in London in 1666 destroyed the infected rats and relieved England of the bubonic plague, which had been endemic in that country since 1349. Something more than one hundred years later the discovery of Jenner robbed smallpox of its horrors, wherever vaccination is properly enforced. The investigations of Howard improved the sanitation of jails and workhouses, and did much to eradicate typhus.

The claim has been advanced that the infectious diseases have benefited the race by the destruction of the unfit. This idea I have combated most vigorously since our study of typhoid fever in the army in 1898. My colleagues and I found that out of 9,481 soldiers who had previously been on the sick report and could not be regarded as possessing standard health, 648, or 6.8 per cent., contracted typhoid fever; whereas, out of 46,384 men who had no preceding illness, 7,197, or 15.3 per cent., developed typhoid fever. More than 90 per cent. of the men who developed typhoid had no preceding intestinal disorder. Under ordinary conditions the strong, busy man, especially the one whose activities demand wide excursions from his home, is more likely to become infected than the one whose sphere of action is more limited on account of infirmity. The reason for this is too obvious to need statement, and it follows that more men than women and more adults than children have typhoid fever. Moreover, the case mortality is greater among the strong, because death in the infectious dis-

eases is often due to the rapidity with which the invading organism is broken up by the secretions of the body cells and the protein poison made effective. From this I have concluded that contagion, like war, destroys the very flower of the race. This view is sustained by the historians of the pestilences of former times.

Thucydides in his description of the plague at Athens says:

Moreover, no constitution, whether in respect of strength or weakness, was found able to cope with it; nay, it swept away all alike, even those attended to with the most careful management.

Procopius in his account of the Justinian epidemic states that youth was the most perilous season, and females were less susceptible than males.

Cogan, in describing the outbreak of typhus at Oxford in 1577, writes:

The same kind of ague raged in a manner over all England, and took away very many of the strongest sort, and in their lustiest age, and for the most part, men and not women and children, culling them out here and here, even as you would choose the best sheep out of a flock.

In his account of the plague of 1665 in London, Boghurst makes the following statement:

Of all the common hackney prostitutes of Luteners-lane, dog-yard, cross-lane, Baldwins-gardens, Hatton-gardens and other places, the common criers of oranges, oysters, fruits, etc., all the impudent drunken, drubbing bayles and fellows and many others of the *rouge route,* there is but few missing—verifying the testimony of Diemerbroech that the plague left the rotten bodies and took the sound.

Like testimony comes from an account of the plague at Moscow:

Drunkards and persons of feeble temperament were less subject to attack.

Davidson observed that typhus fever was more frequent among the robust than the weak. He states that out of 429 cases the spare and unhealthy taken together made only about 17 per cent. He adds that the death-rate among the poor was one in twenty-three, while among the well-to-do it was one in four. The greater mortality of typhus among the higher classes has been noted by Barber and Cheyne and by Braken.

Hurty, nearly a century ago, wrote:

A fever which consigns thousands to the grave, consigns tens of thousands to a worse fate—to hopeless poverty, for fever spares the children and cuts off the parents, leaving the wretched offspring to fill the future ranks of prostitution, mendicancy and crime.

Creighton says:

The best illustrations of the greater severity and fatality of typhus among the well-to-do come from Ireland in times of famine, and will be found in another chapter. But it may be said here, so that this point in the natural history of typhus may not be suspected of exaggeration, that the enormously greater fatality of typhus (of course, in a smaller number of cases) among the richer classes of the Irish families, who had exposed themselves in the work of administration, of justice, or of charity, rests on the unimpeachable authority of such men as Graves, and on the concurrent evidence of many.

A surgeon in the British navy at the time of William III and Anne tells how he was led to practise bleeding in fever as follows:

I had observed on a ship of war, whose complement was near 500, in a Mediterranean Voyage in the year 1694, when we lost about 90 or 100 men, mostly by fever, that those who died were commonly the young, but almost always the strongest, lustiest, handsomest persons, and that two or three escaped by such natural hemorrhages, which were five or six pounds of blood.

The middle ages were indeed dark physically, intellectually and morally. Here and there, now and then, some man of genius towered above the general low level of his contemporaries and not infrequently he paid dearly for his audacity. For some centuries the Arab, especially in Spain, stood out alone as the torch-bearer of science, and he, when driven back into the

insalubrity of Northern Africa, lapsed into barbarism. Neuburger writes:

> Fortunately the fate of medieval medicine was not dependent on Byzantium alone. An admirable illustration of the doctrine of conservation of energy is afforded by the fact that, with the decline of intellectual energy at home, a contemporaneous development of Greek medicine took place abroad, which, if at times misguided, was yet full of vitality, whilst the medical art of the newly arisen world of Islam reached a height unsurpassed during the middle ages.

In the greater part of Europe, ignorance and disease held full sway. In the midst of great calamities "the will-o-the-wisp of superstition is an irresistible attraction and offers the only ray of hope." Strong men, neglectful of their earthly duties, betook themselves to secluded places and lost themselves in dreams of a heavenly paradise. Mysticism, fanaticism and superstition dominated all conditions of men. Rulers, illiterate, immoral and even incestuous, occupied palaces while the masses died of starvation. The history of the time is a record of diseased, degenerated, demented man. There can be no doubt that disease has overthrown civilizations in the past, and there is no surety that it may not do so again. The recent outbreak of the plague in Manchuria and its more recent appearance in Cuba are not without their warnings. It remains to be seen if those who control our government have the intelligence necessary to protect our country against the invasion of pestilence. The failure to provide for camp sanitation in 1898, the behavior of California officials on the finding of plague in San Francisco and the general indifference of national and state authorities toward the eradication of disease discourage the hope that intelligent patriotism is widely distributed among us. As a contemporary of Mr. Dowie and Mrs. Eddy and as a citizen of a country in which the osteopath and chiropractic flourish, I feel some embarrassment in speaking of the fanaticism and ignorance of the dark

The history of medicine is that of mankind. Born in naked ignorance, bound in the swaddling-clothes of credulity and nursed on superstition, medicine has had its savants and its fakers, its triumphs and its failures, its honors and its disgraces. It has attracted and still attracts to its ranks men of the purest motives and those who are impelled by the basest desires. It can be said without fear of contradiction that medicine has done more for the growth of science than any other profession, and its best representatives in all ages have been among the leaders in the advancement of knowledge, but the average medical man conforms in intellect and character to the community in which he lives. The food of the faker is ignorance and he thrives where this commodity is most abundant. The uncontrolled fool moves to his own destruction. This is the only way in which nature can eliminate him. A wise government protects its incompetents from medical and other fakers, but such government can exist only where wisdom predominates.

A study of epidemics shows that in the presence of widespread contagion mankind in the mass tends to revert to the barbaric state. This is the unvarying testimony of all authorities, medical and lay, secular and religious, who have made the records. The historian Niebuhr, in discussing the report on the plague in Athens by Thucydides says:

> Almost all great epochs of moral degradation are connected with great epidemics.

F. A. Gasquet, abbot president of the English Benedictines, in his history of the black death, writes:

> The immediate effect on the people was a religious paralysis. Instead of turning men to God, the scourge turned them to despair, and this not

only in England, but in all parts of Europe. Writers of every nation describe the same dissoluteness of manners consequent upon the epidemic.

A Venetian historian notes the general dissoluteness which followed the disease and its effects in lowering the standard of probity and morals. Covino of Montpellier bears testimony to the baneful effects of the scourge on the morals of those who escaped, and concludes that such visitations exercise the most harmful influence on the general virtue of the world. William of Nangis, in his history of the plague in France in 1348, concludes with the following:

> But alas! the world by this renovation is not changed for the better. For people were afterwards more avaricious and grasping, even when they possessed more of this world's goods than before. They were more covetous, vexing themselves by contradictions, quarrels, strifes and lawsuits.

Many similar references could be given, but these suffice to show that disease breeds ignorance, immorality and strife. Our inquiries into the influence of disease on civilization, however, have brought out the fact that people living in comparative health have within a few generations made beginnings, at least, some, highly creditable, in government, literature and science. The Hellenic tribes of Greece built up their wondrous civilization within a few centuries. It is true that Rome was not built in a day, but the seven hills were covered with houses and temples, the great aqueducts brought abundant supplies of pure water from the mountains and the wonderful sewers remain as evidence of sanitary skill, and all this was accomplished in a relatively short period measured in the history of the race. The world moved forward at a rapid pace with the dawn of science in the last century. It is not extravagant to prophesy that with ten centuries of freedom from disease, both inherited and acquired, the world would be regenerated and the superman be born.

It is not necessary to turn to history for examples of the degrading effects of disease on man. We see it to-day in the physical inferiority, intellectual weakness and moral irresponsibility of those peoples who are still under the domination of malaria and kindred diseases. My illustrious predecessor in this office, Dr. Gorgas, has demonstrated what scientific medicine may accomplish in these pestilential regions, and it is within reason to look forward to the time when the tropics may supply choice locations for civilized man. In like manner the valleys of the Tigris and Euphrates are being reclaimed and Babylon and Nineveh may again become seats of learning and culture. The modern sanitarian is quite competent to rebuild the home in which the cradle of civilization was rocked.

After the last epidemic of the plague in London in 1665 the death-rate, so far as it can be ascertained, fell to between 70 and 80 per 1,000. During the next century it fell as low as 50, but fluctuated greatly with recurring epidemics of typhus and smallpox. In the nineteenth, it gradually and quite constantly decreased and is now about 14. In 1879–80, the first year in which the mortality statistics of the United States possess sufficient accuracy to be of any value, the death-rate in the registered area was 19.8; in 1912 it was 13.9—a decrease of 30 per cent. During the same time the mortality from typhoid fever has decreased 50 per cent.; that from scarlet fever 89 per cent.; that from diphtheria 84 per cent.; that from tuberculosis 54 per cent. Hoffman states that had the death-rate for tuberculosis in 1901 continued there would have been 200,000 more deaths from this cause from that date to 1911 than actually did occur, or the actual saving of lives from

death by tuberculosis accomplished in that decennium averaged 20,000 per year. A battle in which 20,000 are slain stirs the world at the time and fills pages of history later. Preventive medicine measures its successes by the number of lives saved, and 20,000 a year preserved from death from one disease is no small triumph. In the last century the average of human life has been increased fifteen years and this increase could be duplicated in the next twenty years if the facts we now possess were effectively employed.

Hoffman further states that the addition to the material wealth of this country secured by the reduction of deaths from tuberculosis within ten years amounts approximately to 6,200,000 years of human life, covering its most productive period. Medicine discovered the facts which have made this great work possible and has directed their application. With evidence of this kind before them, will our lawmakers listen to those who demand recognition as practitioners of medicine without proper qualification?

The further developments of medicine, both curative and preventive, depend on scientific investigations. The public is the beneficiary and should in every way encourage medical research. By the application of discoveries already made, the burden of disease has been lightened, sickness has become less frequent and less prolonged, a greater degree of health has been secured, the efficiency of the individual and of the nation has been increased and life has been prolonged and made more enjoyable. The federal government and the states should sustain and promote scientific research. That government is the best which secures for its citizens the greatest freedom from disease, the highest degree of health and the longest life, and that people which most fully secures the enjoyment of these blessings will dominate the world.

Medicine consists of the application of scientific discovery to the prevention and cure of disease. All else which may go under the name of medicine is sham and fraud. Without advancement in the physical, chemical and biologic sciences there can be no progressive movement in medicine. Scientific knowledge is gained only by observation and experiment. Before the time of Jenner, we are told by the historian, it was unusual to meet in London one whose face was not marked by smallpox. There was a popular belief that one who had cowpox was immune to smallpox. Jenner put this belief to a scientific test and the result was the discovery of vaccination, and this secured the abolition of this disfigurement and a marked reduction in mortality.

In 1849, a village doctor, with a crude microscope, studied the blood of animals sick with anthrax and compared it with that of healthy ones. He discovered the anthrax bacillus. This work was extended by Davaine, Pasteur, Koch and others, and from this the science of bacteriology has been developed. The particulate causes of many infectious diseases have been recognized, isolated and their effects on animals demonstrated. Many of the mysteries of contagion have been revealed and the conditions of the transmission of disease made known. The fundamental principles of preventive medicine have been developed into a science which is to-day the most potent factor in the progress of civilization.

Finlay suspected a certain mosquito to be the carrier of the virus of yellow fever. Reed and his co-workers demonstrated the truth of this theory and the work of Gorgas has freed Havana from the pestilence and the construction of the Panama Canal is an accomplished fact.

We are sorry for the Greek, whose bodily health, mental strength and moral sense were depressed by the invisible and insidious organisms of malaria, and truly his memory deserves our sympathy. He had no microscope, and how could he detect or even suspect that the mosquitoes which had annoyed his ancestors for generations had armed their lancets with deadly poison brought from Africa? The Greek had never heard of quinin and the other cinchona alkaloids. He did not know the land whose forests were even then elaborating those products, which, centuries later, were of greater value than gold to man, and proved to be an essential help in the uplift of mankind. Laveran discovered the *Plasmodium malariæ*. Ross studied its life history and the fetters of this disease, which has so long retarded the progress of man, have been broken. Mitchell and Reichart investigated the poisonous properties of snake venom. Sewall immunized animals with it. Ehrlich studied the similar bodies, abrin, ricin and diphtheria toxin, and von Behring and Roux gave the world antitoxin, the magical curative value of which has greatly reduced the mortality from this disease. The experiments of Villemin demonstrated the contagious nature of tuberculosis, long suspected and frequently denied. The diligent research of Koch resulted in the recognition and isolation of the causative agent, and since this discovery the mortality of the Great White Plague in Europe and the United States has been diminished more than half, and it is within the range of sanity to look forward to the time, when the former "Captain of the hosts of death" will be known only by the fearful records he once made in the history of man's struggle to be relieved from the heavy tribute paid to infection.

We boast of a great civilization, but this is justified only within limits. Science more nearly dominates the world than at any time in the past. Learning permeates the masses more deeply, but credulity and ignorance are widely prevalent. In this country of nearly one hundred millions, there are thousands whose greed impedes the progress of the whole, tens of thousands whose ignorance retards their own growth, and other thousands who live by crime and procreate their kind to feed on generations to come. We have our schools, colleges and universities, while our almshouses, insane asylums and penal institutions are full. In our cities we see the palatial homes of the ultra rich, the splendid temples of trade and commerce, the slums of want and poverty and the homes, both rich and squalid, of vice and crime. No nation in this condition can be given a clean bill of health. Our hill-tops are illuminated by the light of knowledge, but our valleys are covered by the clouds of ignorance. We have not emerged from the shadows of the dark ages. The historian of the future will have no difficulty in convincing his readers that those who lived at the beginning of the twentieth century were but slightly removed from barbarism, as he will tell that the school, saloon and house of prostitution flourished in close proximity; that the capitalist worked his employees under conditions which precluded soundness of body; that the labor union man dynamited buildings; that whilst we sent missionaries to convert the Moslem and the Buddhist ten thousand murders were committed annually in our midst, and that a large percentage of our mortality was due to preventable disease.

Evidently there is much to be done before we pass out from the shadows of ignorance into the full light of knowledge. In this great work for the betterment of the race the medical profession has important duties to perform. I do not mean to

imply that the uplift of mankind devolves wholly on the medical man. The burdens are too many and too diversified, the ascent too steep and the pathways too rough for one profession to hope to reach unaided the high plateau we seek. Moreover, other callings have no right, and should have no desire, to shirk the moral responsibilities, which rest alike on all. But in past ages, medical men have been the chief torch-bearers of science, the only light in which man can safely walk, and we must keep and transmit to our successors this trust and honor. I know of no scientific discovery, from the ignition of wood by friction to the demonstration of the causes of infection and the restriction of disease, which has not sooner or later assisted in the betterment of the race. It may be added that nothing else has so aided man in his slow and halting progress from the pestilential marshes of ignorance to the open uplands of intelligence.

In so great a work as the eradication of preventable disease, all intelligent people must cooperate. The law must support by proper enactments, and these must be enforced with justice and intelligence; it must recognize that the right to enjoy health is quite as sacred as that to possess property; that to poison men in factories and mines, to pollute drinking-water supplies, to adulterate foods and to drug with nostrums is manslaughter. Religion must teach the sanctity of the body as well as that of the soul, that ignorance is sin and knowledge virtue, that parenthood is the holiest function performed by man and that to transmit disease is an unpardonable sin. The teacher must know hygiene as well as mathematics. The capitalist must recognize that improvement in health and growth in intelligence increase the efficiency of labor. There never has been a time when scientific medicine has had so many and such efficient and appreciative helpers as it has to-day. Our sanitary laws are for the most part good, but their administration is weak, on account of ignorance. The pulpits of the land are open, for the most part, to the sanitarian. The respectable newspapers are most effective in the crusade against quackery and disease. The philanthropist has learned that the advancement of science confers the greatest and most lasting benefits on man.

There is a moral obligation to be intelligent. Ignorance is a vice and when it results in injury to any one it becomes a crime, a moral, if not a statutory one. To infect another with disease, either directly or indirectly, as a result of ignorance, is an immoral act. The purpose of government is to protect its citizens, and a government which fails to shelter its citizens against infection is neither intelligent nor moral. To transmit disease of body or mind to offspring is an unpardonable sin. In a reasonable sense it is worse than murder, because it projects suffering into the future indefinitely.

That medicine has become a fundamental social service must be evident. To return one incapacitated by illness or injury to the condition of self-support benefits not only the individual, but the community, inasmuch as it increases its productive capacity. Infirmity is a direct burden on the individual and scarcely less direct on the community. Weakness in any part diminishes the strength of the whole. It is a fully established principle in social economy that wide-spread intelligence and growth in knowledge are beneficial to the state.

It was in full recognition of this that the framers of the Ordinance of 1787 wrote into that immortal document:

Religion, morality and knowledge being necessary to good government and the happiness of

mankind, schools and the means of education shall forever be encouraged.

The Territory of the Northwest, the government of which was provided in this ordinance, was at that time a vast waste of forest and prairie, furnishing a scant and precarious subsistence for savage tribes and attracting to its borders a few of the most hardy sons of civilization. The knowledge for whose growth and diffusion the wise provision was made, has drained the malarial marshes, converted wild prairie and tangled wood into fruitful orchards and fertile fields, dotted the whole area with neat villages, reared great cities, linked all parts with steam and electric roads, and provided comfortable homes and abundant food for millions. The men who wrote the Ordinance of 1787 left a great inheritance which is temporarily in our possession. Let us write into this great document:

Every ill which can be relieved shall be removed, and every preventable disease shall be prevented.

The wisdom of our fathers has secured for us a greater measure of health and a longer term of life; let us do as well for those who are to possess this fair land in the next generation. Let us live not only for ourselves and the present, but for the greater and more intelligent life of the future.

Not myself, but the truth that in life I have spoken
Not myself, but the seed that in life I have sown
Shall pass into ages—all about me forgotten,
Save the truth I have spoken, the things I have done.

All things are relative and health is no exception. With a greater degree of health among all, religion will become more effective for good, morality will have a deeper significance and a wider application and knowledge will multiply and distribute its blessings more widely.

In the further improvement of the physical, mental and moral conditions of the race, medicine should continue to be a leader. There is no other calling so essential to this movement, and in order to more thoroughly fit itself for this important task the profession should first of all look to its own betterment. The medical man should possess intelligence of high order, manifest industry without stint and show the highest integrity in all he does. That it is the aim of this association to attract to its colors men possessing these qualifications and to deny admission to others is shown by the advance in the standard of medical education, the enforcement of medical registration laws and the denunciation of every form of medical charlatanism. In all these directions the profession has the support of the more intelligent men in other callings. The improvement in medical training secured within recent years in this country is without a parallel in the history of education. The requirements for admission to the medical schools have been rapidly advanced and standardized; the number of medical schools has been reduced from 166 to 104 by obliteration and combination, much to the improvement of all, and a far better class of matriculates has been secured. The courses of instruction have been lengthened and made more scientific. Each good medical school is doing more or less of research which is not confined to laboratory investigators, but is fast finding its way into hospitals. Indeed, some of our clinical men are now making most valuable contributions. Every medical man should have much of the spirit of research. It is the pabulum on which medicine feeds and without it the profession atrophies and starves. It is the glory and strength of the profession that it is not bound by dogma and pays no heed to ipse dixits. I have no sympathy with the idea that medical research should be

largely relegated to special non-teaching institutions. These have their function and we rejoice in their foundation and support and hope that they may multiply, but the man who is devoid of the spirit of scientific investigation has no place in medicine as student, practitioner or teacher, and the most elaborate medical training without opportunity for scientific observation is barren. Besides, opportunities for medical discovery should be widely distributed. Science makes no provision for an aristocracy. There can be no papal bulls issued in the domain of medicine. The workers must be many, all must be free to pursue knowledge in their own way, and all must be compelled to prove their claims, for "life is short, art is long, opportunity is fleeting, experiment fallacious and judgment difficult."

In this work of self-improvement the profession has had the aid of the more intelligent law-makers and administrators. In carrying out these progressive changes there has been much sacrifice of money and personal pride by many members of the profession. Large schools have willingly submitted to marked reduction in the numbers of their students and consequently in financial support. A medical education costs more in time and money than that demanded by any other profession, and the emoluments of the average practitioner have decreased as preventive medicine has become more effective. No other profession pays so heavily the great cost of eradicating the infectious diseases, but this is the function of medicine and no sacrifice should be regarded as too great. While intelligent medical men have been leading the crusade against greed, ignorance and disease, our legislative halls have been crowded with the representatives of sects, cults and charlatans demanding legal recognition. If I mistake not, herculean efforts will be made in the near future to lower the standards demanded of the medical practitioner. These endeavors have been promised aid from those who have heavy financial backing, but if we are worthy of the trust which we bear, we shall not yield. We must appeal to the good sense of the people for whose welfare we labor. We must show what scientific medicine has done for the public good and point out the greater things it may do with increased opportunity. It must be admitted that in the crusade for the restriction of tuberculosis many physicians have manifested but little interest. This is shown by their slowness to employ methods of early diagnosis and consequently by their failure to recognize the disease in its curable stage, also by their unwillingness to comply with the laws of notification. It is an undeniable fact that there are many medical men who know less about hygienic measures than the more intelligent of the laity. With advancing knowledge among the masses these professional fossils will be correctly labeled and properly shelved in the local museums of antiquities.

I believe that medicine is now attracting excellent young men. It should appeal to this class. It does not point the way to great financial reward, but it offers a service unsurpassed by any other calling. The historian tells us:

> For the Roman patriot the only worthy stage was the forum or the battlefield; every other pursuit was left in the hands of slaves and could not free itself from the taint of servitude.

Modern medicine offers a field in which the advancement of knowledge, the improvement of health conditions and the saving of lives are the measures of success.

Preventive medicine, still in its youth, has accomplished great things. As I have stated, within the past thirty years in this country the mortality from tuberculosis

has been reduced more than half and with scarlet fever and diphtheria the results have been more striking. Within the past ten years the average life has been increased four years. Great epidemics which once devastated continents are no longer known in the more intelligent parts of the world. In fact, it may be said that the death-rate is now an excellent measure of intelligence. In 1911 the death-rate in London was 15 per one thousand, while that of Moscow was 27.3. Preventive medicine is the keystone of the triumphal arch of modern civilization, and its displacement would precipitate mankind into relative barbarism. Should the health administrators of any great commercial center fail, for even a few months, to exercise the function of restricting disease, the history of the epidemics of the middle ages might be repeated. Great things have been done, but greater tasks lie before us, and their accomplishment depends on the scientific wisdom of our profession and the intelligence of the people. Without the harmonious adjustment of these forces the greatest efficiency can not be secured. While the mortality from tuberculosis has been reduced half in the past thirty years, we must not assume that the total eradication of this disease will be accomplished in the same number of years. Only the more progressive members of the profession have taken the initiative, and only the more intelligent members of the community have responded. Intelligence and the sense of moral responsibility must grow as the work proceeds. It remains for all who have the welfare of the race at heart to plan wisely and carry forward courageously the campaign against greed, ignorance and disease.

The sanitarians of this country seem to be in harmony in regard to the general procedures to be followed. These are embodied in bills recently introduced in the legislative assemblies of a number of states. In New York an excellent bill was passed and its operation is now being inaugurated under the directorship of Dr. Biggs, whose long and effective service in the city of New York demonstrates the wisdom of his selection. I regard it as highly fortunate that the operation of this new and important law is to be directed by one so well qualified.

My own ideas are embodied in the "Amberson bill" of the Michigan legislature of 1913. Among the provisions of this bill the following may be mentioned: The state is to be divided into health districts. In each such district a health commissioner is to be appointed for a term of four years. The fitness of the commissioner is to be determined by the State Board of Health after examination. The salary of the commissioner varies with the population of the district, but in most instances would run from three to six thousand dollars. There is to be an additional appropriation for laboratory expenses and for carrying out the purposes of the act.

It shall be the duty of the health commissioners to be vigilant in the work of disease prevention and the conservation of the public health, and to enforce all health laws of the state and health ordinances of their respective localities, together with all rules and orders of the state board of health; to collect and report to the state board of health morbidity statistics and to make a monthly report of the work done by them in narrative form to the state board of health and in such tabular form as may be prescribed by the state board of health. Copies of such reports shall be retained by each commissioner in permanent record books. They shall make such sanitary inspections and surveys of the district as may be required from time to time by the state board of health or by the city for which appointed, or by resolution of the board of supervisors of each county. They are hereby authorized and invested with the power to enter on and inspect private property at proper times in regard to the possible presence, sources or cause of

disease, to establish quarantine and in connection therewith to order whatever is reasonable and necessary for the prevention and suppression of diseases; to close schools, churches, theaters, or any place of public assemblage, to forbid public gatherings in order to prevent or stay epidemics; to collect statistics concerning insanity, feeble-mindedness, tuberculosis and other infectious diseases; to inspect slaughter-houses and markets of all kinds where food is sold. They shall inspect at least once each six months and make a sanitary survey of the publicly owned buildings and institutions within their respective jurisdiction and shall keep a report thereon as part of the records of their office. They may inspect any school buildings or grounds within their jurisdiction as to sanitary conditions and shall have power to close any school when the sanitary conditions are such as to endanger or imperil the health or life of the pupils attending the same. They shall include all such sanitary inspections in their monthly reports to the state board of health. They shall at all times be subject to the orders of the state board of health in the execution of the health laws of this state and may perform any duty where required by the state board of health, or any member of said board acting for the entire board, which might be performed by said board of health or an officer thereof.

Further duties of the health commissioners are defined in the bill, and I have given only enough to show the purpose and scope of its provisions.

The successful operation of such a law would require the highest class of sanitarians. They must possess intelligence, industry and integrity. They must be devoted to their work, remembering that the Father of Medicine said:

Where love of mankind is, there also is love of art.

With these qualifications I believe that such a law might be operated with great benefit to the people. Is the medical profession of this country prepared to do this work? I believe that many of the recent graduates of our best schools are fitted for this highly important function. They may need special training in the courses in public health now being inaugurated. If I mistake not, our profession will soon have wide opportunity to demonstrate its usefulness in this direction. If the public makes this demand, preventive medicine will have the opportunity to do a patriotic service which has never come to any profession at any time. With proper facilities and helpers, such commissioners might within a few years become acquainted with the conditions surrounding every permanent resident within his jurisdiction, and with properly qualified administrators of the law much might be done to abate disease, improve health, increase efficiency, eradicate the venereal diseases, stamp out vagrancy, pauperism, prostitution, alcoholism and crime. Crime is a disease due to heredity or environment, one or both. We now permit it to breed and multiply in our midst. Its causes must be determined and eliminated and its habitations must be discovered, disinfected or destroyed. We have heard too much about the rights of the individual; let us know more about his duties. Too much stress has been laid on the sacredness of private property and too little on the duty of all to contribute to the welfare of the whole. Preventive medicine has demonstrated in a practical way the force of the biblical statements that no man liveth to himself alone, and that every man is his brother's keeper. Preventive medicine is the most potent factor in the socialistic movement of the day with which every good man feels himself more or less in sympathy; besides it is at the same time the most powerful weapon against the anarchy with which some would threaten us.

If preventive medicine is to bestow on man its richest service, the time must come when every citizen will submit himself to a thorough medical examination once a year or oftener. The benefits which would result from such a service are so evident to medi-

cal men that detail is not desirable. When recognized in their early stages most of the diseases which now prevail are amenable to treatment. The early recognition of tuberculosis, cancer, diabetes, nephritis, heart disease, etc., with the elimination of the more acute infectious diseases would add something like fifteen years to the average life, besides saving much invalidism and suffering. The ultimate goal of science is the domination of the forces of nature and their utilization in promoting the welfare of mankind. Science must discover the facts and medicine must make the application for either cure or prevention.

The local health authorities for which the bills referred to make provision must be supervised by State Boards of Health or State Commissioners. Many of our State Boards of Health are already doing much, but this is little compared with what they might do. They should be absolutely free from party dictation, should be made up of men both qualified and interested and their executive officers should be distinguished for their knowledge of sanitation. Their appropriations should be greatly increased, for health is a purchasable commodity. Pure water, pure food and even pure air cost money, but they lead to health, which is worth more than gold to both the individual and the state.

Our present national health service is doing most excellent work. It demonstrated its strength in eradicating the plague in California and the suppression of yellow fever in New Orleans. It has charge of the administration of the laws affecting the admission of immigrants, so far as their health is concerned, and it performs this service well. The Public Health Service is now investigating the pollution of certain rivers, studying trachoma in the mountains of Kentucky, pellagra in South Carolina and the spread of typhoid fever in certain districts. The Hygienic Laboratory at Washington has made valuable researches in addition to the routine work of the examinations of vaccines and serums. This bureau should be developed into a department with a member in the cabinet. The study of contagion in our midst is quite as important as anything within the range of the activities of the Departments of the Interior, Agriculture and Commerce and Labor. Our health relations with other nations concern us quite as much as our trade relations. The one thing above all others against which our doors should be shut is disease, whether it be of plant, animal or man, whether it be of body, mind or morals. The highest function of the state is not to make millionaires out of a few importers or to find profitable investments for its surplus wealth in foreign lands, but to advance to the highest degree the health, intelligence and morality of its citizens.

In each state there should be a hygienic laboratory equipped with able men supplied with facilities for the study of sanitary conditions and for the prosecution of scientific research. The Hygienic Laboratory at Washington should be developed into a great institution for research which would improve the conditions of life. The greatest asset of any nation is the health of its citizens and the people who secure this in the highest degree will dominate the earth for the dominion of the superman, when he comes, will extend from pole to pole, not by force of arms, but by example and education.

Younger members of the profession: One who is soon to be mustered out of service, on account of disability and old age, salutes you. An old soldier who has served in the ranks for nearly forty years steps from his decimated regiment, lifts his cap and cheers you, as you pass by in your new dress and armed with weapons of greater efficiency

than were known when he enlisted. The cause is the liberation of the race from the bonds of superstition and ignorance and it is a glorious one. The contest began before the genus *homo sapiens* came into existence. Countless generations have served their time, some well, some ill, and have passed into oblivion, but their partial victories have made you stronger and placed on you a greater responsibility. Your intelligence is greater, your judgment is sounder and your effectiveness has been increased. Where the past has failed or only partially succeeded, your success will be greater. But the battlements of ignorance still bristle with heavy-fire guns. Only a few of the outposts of the enemy have been captured. It is for you to do and then like all your predecessors to die. You stand to-day within the firing-line. Go on courageously and when eons of the future have become the past, the superman, born out of the struggles of his predecessors, will demolish the last citadel of ignorance and vice, and firmly plant on the highest peak of the mountain of knowledge the flag of human progress and when the silken banner shall unfold, there shall appear on it this legend:

Pro gloria omnium nationum et hominum honore.

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A FOSSIL HUMAN SKELETON FROM GERMAN EAST AFRICA

AT a meeting of the *Gesellschaft naturforschender Freunde* in Berlin on March 17, 1914, Dr. Hans Reck made a preliminary report on a discovery that is of special interest to anthropologists. Dr. Reck was attached to a geological expedition that had been sent out to survey a parallel running through the northern end of German East Africa, as well as to collect for the Geologic-Paleontologic Institute of the University of Berlin and the Paleontological Museum at Munich.

The discovery in question was made in Oldoway hollow or gorge on the eastern margin of the Serengeti steppe. The Oldoway gorge lays bare a series of tufaceous layers that had been deposited in a freshwater lake. Five deposits can be distinguished stratigraphically as well as paleontologically. In the lowest deposit fossil remains are rare, the chief specimen being a part of a rhinoceros skeleton. The second deposit is rich in fossil mammalian remains, including the human skeleton. Remains of two types of fossil elephant, both different from the living *Elephas africanus,* were especially abundant; the skull of a hippopotamus was also found in deposit number two. Bones of the antelope appear for the first time in the third deposit, which also contains bones of the elephant. Elephant remains are dominant in the fourth deposit; fish bones are also abundant. The fifth and latest of the deposits is the richest of all in fossils. It is characterized by an antelope and gazelle fauna similar to that now living on the Serengeti steppe. In this deposit Reck found no elephant remains.

The change in fauna represented by the series corresponds to a change in climate. The climate of the upper horizon was similar to that of to-day; while the elephant, rhinoceros, hippopotamus, crocodile, and fish of the lower horizons bespeak a damp woodland climate that was probably synchronous with the Würm glacial epoch in Europe.

The human skeleton, as has been said, came from the next to the lowest horizon (No. 2). It is not only in a good state of preservation, but is likewise practically complete. The skeleton was found some three or four meters below the rim of the Oldoway gorge, which here is about fifty meters deep. The skeleton bore the same relation to the stratified bed as did the other mammalian remains and was dug out of the hard clay tuff with hammer and chisel just as these were. In other words the conditions of the find were such as to exclude the possibility of an interment. The human bones are therefore as old as the deposit (No. 2).

An attempt to determine the age of the

human skeleton with any degree of accuracy must of course wait upon a further study of the geologic and paleontologic data as well as on a more thoroughgoing somatologic study of the skeleton itself. Dr. Reck is, however, already convinced that it antedates the so-called alluvial or recent period. The thickness of the deposits indicates a considerable lapse of time, especially when one recalls that at least two of the superposed deposits were laid down before the faulting occurred, and with it the drying up of the lake. The change in fauna from rhinocerous, hippopotamus and two types of elephant both different from the living African elephant, to a gazelle and antelope fauna is likewise proof of considerable antiquity. Judging from the photograph of the skeleton still in situ, the man of Oldoway gorge did not belong to the Neandertal, but rather to the Aurignacian type of man. In the absence, however, of industrial remains and even photographs in detail, any pronouncement as to racial affinities with known European Quaternary human remains would be merely a guess.

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THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

A statement has been given out from the Rockefeller Institute for Medical Research to the effect that in order that further opportunities may be afforded for the more complete investigation of the nature and causes of human disease and methods of its prevention and treatment, Mr. John D. Rockefeller has just donated $2,550,000 to the Rockefeller Institute for Medical Research.

Of the sum just donated a part will be utilized to purchase additional land in New York City so that the Institute will have acquired the entire tract where its buildings are now located, between Sixty-fourth and Sixty-seventh Streets on Avenue A, extending through to East River—about four acres. The remainder will be used to erect and equip additional laboratories, buildings, and plant, and to insure the proper maintenance and conduct of the extended work.

This gift of $2,550,000 is in addition to a special fund of $1,000,000 which Mr. Rockefeller has provided in order that the institute may establish a Department of Animal Pathology. Dr. Theobald Smith, now professor of comparative pathology in Harvard Medical School, is to become director of the new department.

It will be the purpose of this branch of the institute's work to give special attention to the study of maladies such as hog cholera, foot and mouth disease, and diseases of poultry, which are of such immediate and practical concern to farmers, and the elimination of which is so important. This will be the first enterprise of this kind upon an adequate basis to be established in this country. The results of its work should eventually be of great value in improving the health of cattle and other farm animals.

Mr. Rockefeller's previous gifts to the institute had amounted to practically $9,000,000, exclusive of real estate in New York City, so that the endowment of the institute will now approximate $12,500,000.

The Rockefeller Institute will, with the new gift, now become the most amply endowed institution for medical research in the world. In 1902, when the institute was founded, there was not a single undertaking of the kind in this country. England had the Lister Institute, Germany the Institute for Infectious Diseases, France the Pasteur Institute and Russia the Royal Military Institute at St. Petersburg. Since 1902 a number of other research laboratories have been established in this country, including several in Chicago.

In addition to the laboratories there is connected with the institute a hospital with every improved facility for the treatment of patients afflicted with diseases at the time under special investigation. For the treatment and study of contagious diseases—a most important phase of the institute work—there is a separate building with isolated rooms.

The aims of the Rockefeller Institute and the lines along which its future work—upon

an even more comprehensive basis—will be conducted, are indicated by some of its practical achievements already accomplished, such as the serum treatment of epidemic meningitis; the discovery of the cause and mode of infection of infantile paralysis, the surgery of blood vessels through which blood transfusion has become a daily life-saving expedient; the safer method of administering anesthetics by intratracheal insufflation; the skin or luetic reaction and the cultivation of the parasite of rabies.

The scope of the work of the institute will be indicated by a list of the several special scientific departments which it maintains. It includes pathology, bacteriology, protozoology, biological chemistry, physiology and pharmacology, experimental biology, and animal pathology, besides the special hospital.

BEQUESTS OF MRS. MORRIS K. JESUP

MRS. MORRIS K. JESUP, who died on June 17, bequeathed $5,000,000 to the American Museum of Natural History and made other bequests to public institutions amounting to $3,450,000. In providing in her will for the American Museum of Natural History, Mrs. Jesup said:

> I give and bequeath to the American Museum of Natural History of the city of New York four million dollars ($4,000,000) as a permanent fund to be known as "The Morris K. Jesup Fund," the income, and only the income, to be used in the purchase of specimens and collections and the expenses incident to and incurred in assisting scientific research and investigation and publication regarding the same, which the trustees of the museum shall regard as in its interests.

In a codicil, added to her will three years after the will was drawn, an additional $1,000,000 is given to the museum. Morris K. Jesup, who died on January 22, 1908, became president of the museum in 1882, and devoted a large part of his time and energy to its interests. In his lifetime Mr. Jesup gave more than $1,000,000 to the museum, and under his will it inherited an additional $1,000,000.

Other public bequests made by Mrs. Jesup include the following:

Syrian Protestant College	$400,000
Yale University	300,000
Union Theological Seminary	300,000
Young Men's Christian Association	250,000
New York State Woman's Hospital	150,000
Williams College	150,000
Metropolitan Museum of Art	100,000
Presbyterian Hospital	100,000
Hampton Institute	50,000
Tuskegee Institute	50,000
Northfield School	25,000
Mount Hermon School	25,000
New York Zoological Society	25,000
New York Botanical Gardens	25,000
Memorial Hospital for Cancer	10,000
St. Luke's Hospital	10,000
Cooper Union	10,000

SCIENTIFIC NOTES AND NEWS

THE American Medical Association at its meeting at Atlantic City elected officers for the meeting to be held next year at San Francisco as follows: President, Dr. William L. Rodman, of Philadelphia; first vice-president, Dr. D. S. Fairchild, of Iowa; second vice-president, Dr. Wisner R. Townsend, of New York; third vice-president, Dr. Alice Hamilton, of Chicago; fourth vice-president, Dr. William Edgar Darnall, of Atlantic City; secretary, Dr. Alexander R. Craig, of Chicago, reelected; treasurer, Dr. William Allen Pusey, of Chicago.

AT the opening meeting of the American Medical Association, its gold medal was conferred on Surgeon General William Crawford Gorgas.

WESTERN RESERVE UNIVERSITY has conferred its doctorate of laws on Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research.

AMONG the degrees conferred by Harvard University at its commencement exercises were the master of science on Dr. Milton J. Rosenau, professor of preventive medicine in the Harvard Medical School, and the degree of doctor of science on Dr. W. C. Sabine, professor of physics and dean of the graduate school.

DR. WILLIAM L. DUDLEY, dean of the medical department and director of the chemical

laboratories of Vanderbilt University, Nashville, Tenn., *had conferred upon him the degree* of LL.D., by the University of Cincinnati, at its recent commencement.

Miss Ellen Churchill Semple, of Louisville, Ky., author of works on anthropogeography, has received the Cullom Medal of the American Geographical Society.

The University of Paris has approved the nomination of Professor James Rowland Angell, head of the department of psychology, and dean of the faculties of arts, literature and science in the University of Chicago, as lecturer at the Sorbonne in 1915.

A Martin Kellogg fellowship in the University of California has been awarded to Mr. C. E. Adams, government astronomer of New Zealand, who will carry on research work at the Lick Observatory.

Norman R. Blatherwick, Ph.D. (Yale), has been appointed assistant chemist at the Montefiore Home in New York City.

Mr. C. M. Means, electrical engineer, Pittsburgh, Pa., has been appointed consulting electrical engineer with the U. S. Bureau of Mines.

Professor H. Hergesell, of Strassburg, has been appointed director of the Royal Prussian Aeronautical Observatory at Lindenberg, near Berlin.

Dr. Edward A. Spitzka has resigned as professor of anatomy at Jefferson Medical College. He plans to take up the practise in New York City of his father, the late Dr. Charles Edward Spitzka, who died last January.

Professor J. Miller Thomson, F.R.S., is retiring at the end of this session from his position as vice-principal of King's College, London, and head of the chemical department of the college, after a service of forty-three years.

The Museum of Zoology, University of Michigan, will have a field party in the Davis Mountains, Texas, during July and August. The members of the party, Miss Crystal Thompson, of the museum, and Miss Myra M. Sampson, Smith College, will study the ecological distribution of the reptiles, amphibians and certain groups of invertebrates, principally the butterflies, molluscs and crustaceans.

Dr. Frederick W. True, assistant director of the Smithsonian Institution, known for his contributions to zoology, especially of the Cetacea, died on June 25 in Washington at the age of fifty-five years.

Dr. George Dean, professor of pathology in the University of Aberdeen, died on May 30 at the age of fifty years.

Professor Hugo Kronecker, of Bern, distinguished for his contributions to physiology, died on June 6, at the age of seventy-five years.

Professor Adolph Lieben, emeritus professor of general and pharmaceutical chemistry in the University of Vienna, died on June 6, aged seventy-eight years.

The International Congress of Anatomy will hold its next meeting at Amsterdam in August, 1915.

The interest of Lady Huggins, the widow of the late Sir William Huggins, in the higher education of women in science as developed in the United States has been shown by her gift to Whitin Observatory of Wellesley College of certain of her more personal astronomical possessions. The gift includes two stained glass windows once in Tulse Hill Observatory House, a beautifully wrought Arabian astrolabe, pocket sun dials of the eighteenth century, several exquisite portable instruments especially made for Lady Huggins, and a grating ruled and presented to Sir William Huggins by Rutherford, of New York, and used in his earlier work. There are also interesting pictures, drawings and books. These are properly placed in the Whitin Observatory to form a Huggins memorial collection. The astronomers from Harvard College Observatory and the Astronomical Laboratory were present at the formal presentation and Professor E. C. Pickering made an address.

The Smith-Lever bill, an act to "provide for cooperative agricultural extension work between the agricultural colleges in the several states receiving the benefits of an Act of Congress approved July 2, 1862, and of acts

supplementary thereto," has been passed by Congress and approved by the President. The act makes available for the next nine fiscal years an aggregate sum of $23,120,000 of federal funds to be expended in instruction and practical demonstrations in agriculture and home economics. To obtain this total the states must appropriate for like purposes a total of $18,800,000. Thereafter the government is to appropriate $4,580,000 annually, and the states to take their full quota must appropriate $4,100,000 annually. The purposes for which the funds are to be expended are defined by the act as follows: "That cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and imparting to such persons information in such subjects through field demonstrations, publications and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the state agricultural college or colleges receiving the benefits of this act." Beginning with the year 1914–15 the act appropriates $10,000 to each state as a basic fund for each fiscal year. The act then appropriates additional federal moneys to be distributed among the states according to the percentage that the rural population of each state bears to the total population of that state. To share in the additional funds the state must duplicate the money received from the government in appropriations for the same purpose. According to the *Cornell Alumni News* from which the above is taken the amounts available to the College of Agriculture at Cornell, based on the percentage of rural population in New York State, will begin next year with the basic $10,000 granted each year, and will increase annually according to the following table: 1915–16, $33,443; 1916–17, $52,979; 1917–18, $72,515; 1918–19, $92,051; 1919–20, $111,587; 1920–21, $131,123; 1921–22, $150,659; 1922–23 and thereafter, $170,195.

A SOUTHERN GEOGRAPHIC SOCIETY has been established at Knoxville, Tenn., for the purpose of stimulating the interest of its members and of the public in the study and appreciation of the science of geography. It is planned to hold monthly meetings, on the second Friday evening, from October to May, inclusive, at which addresses or lectures will be given in which will be presented the results of studies, travels and researches pertaining to the science of geography, and related subjects. From time to time excursions will be conducted by the society for the study of features of geographic interest. One of the features in the plans of the society is that of a field school of geography and nature study, which it is proposed to conduct in connection with the Summer School of the South. Beginning with the summer of 1915 it is proposed to conduct at a suitable place in the mountains for a period of four to six weeks, a camp school for the study of geography and related subjects, including plants, animals, physiography, geology, forestry, etc. From day to day excursions will be made under competent instructors for the study of the flora, the fauna and the physical features of the region.

AFTER making investigations and collecting data for the last 12 years, the Ohio State Archeological and Historical Society has published an Archeological Atlas of Ohio which is the first book of this kind to be published by any state. Dr. William C. Mills, the curator of the museum of the society which is located on the campus of The Ohio State University, is the author of the book. A map of each county of the state, showing the mounds, village sites, rock shelters and other interesting archeological matter is the chief feature of the new book. Opposite each map is a description of the county. Other maps show the early Indian trails and towns, and the principal mounds and other earthworks of the entire state. The frontispiece is a photograph of the Serpent mound located in Adams county. Other photographs are included of the various forts, Indian trails and mounds which are described by the author.

IN a report on the Museum-Gates Expedition which investigated the culture of the ancient pueblos of the upper Gila River region

of New Mexico and Arizona, Dr. Walter Hough, of the U. S. National Museum, states that among thousands of interesting and valuable objects pertaining to the lives of the early inhabitants, many dried vegetables, fruits, and other perishable articles were found, as well as a desiccated turkey. In a cave which formed the rear chamber of a row of ruined stone abodes, on the banks of the Tularosa River, a tributary of the San Francisco River, the explorers found much material representative of the domestic life of the ancient dwellers. Upon excavation, this cave room yielded its treasures in sections as it were, different depths offering distinctly marked periods of occupation. Among the objects of importance was a brush made of grass stems bound in a round bundle, similar to those in use by the Pueblo Indians of to-day. During the habitation of this cave four burials had been made at different times, shown by the different levels from which the digging had been begun. In one corner near a rock mass some small bows and arrows, and other offerings were unearthed, indicating the location of an ancient shrine. From the rubbish and débris the remains of several mammals and birds were identified; among them, deer, pronghorn, bison, woodchuck, mice, rats, muskrats, rabbits, lynx, fox, skunk, bear, a hawk, an adult turkey, chicks and eggs, and many feathers of other birds, all of which occupied the cave at one time or another, or were killed and stored there by the early Indians. From early historical reports, it has been understood that the Pueblos raised turkeys, but the discovery of this desiccated adult and chicks proves conclusively that turkeys were kept in captivity, probably for their feathers, which were used in the manufacture of native garments. Ears and scattered grains of corn of a smooth and short grain, in yellow corn, blue and carmine but much faded with aging, were also found, as well as the remains and seeds of gourds, squashes, beans, other vegetables and fruits and nuts. In the Tularosa cave there was pottery of a rude form, while from several large open-air pueblos examples of a very fine finish and ornamentation were collected. The designs on the bowls commonly consist of four elements based on the world quarters, the bottom usually being circular and blank. Other designs are of combined hatched and solid color, or of a checkered variety. Many small collections of pottery were found in caves and springs where they had been deposited as offerings.

According to Ernest F. Burchard, of the U. S. Geological Survey, the total quantity of Portland, natural and puzzolan cement produced in the United States last year was the greatest in the history of the cement industry, amounting to 92,949,102 barrels, valued at $93,001,169, compared with 83,351,191 barrels, valued at $67,461,513, in 1912. The total production of Portland cement in 1913 as reported to the Geological Survey was 92,097,131 barrels, valued at $92,557,617; the production for 1912 was 82,438,096 barrels, valued at $67,-016,028. The quantity of Portland cement produced, 92,097,131 barrels, is equivalent to 15,623,620 long tons. Compared with the production of pig iron for 1913, which was 30,966,-301 long tons, the Portland cement production is nearly 50.5 per cent. of the quantity of pig iron. Of the 113 producing plants in the United States in 1913, 23 were in the state of Pennsylvania, whose output was 28,701,845 barrels of Portland cement, the largest quantity produced by any one state. The second greatest production came from Indiana, with 10,872,574 barrels, and California was third, with 6,159,182 barrels. The natural cement produced in the United States in 1913 amounted to 744,658 barrels of 265 pounds each, valued at $345,889, compared with an output of 821,231 barrels, valued at $367,222, in 1912, a decrease in 1913 of 76,573 barrels and of $21,333 in value. Puzzolan cement was manufactured in 1913 at three plants in the United States, in Alabama, Ohio and Pennsylvania. The output of puzzolan and Collos cements in 1913 was 107,313 barrels, valued at $97,663, compared with 91,864 barrels, valued at $77,363 in 1912, an increase in quantity of 15,449 barrels and in value of $20,-300. The United States has a comparatively small export trade in cement. In 1913 the

total quantity exported was only 2,964,358 barrels, most of which was Portland cement, valued at $4,270,666, compared with 4,215,232 barrels, valued at $6,160,341, in 1912.

UNIVERSITY AND EDUCATIONAL NEWS

The gift of $400,000 to the Yale Medical School, recently announced, is from members of the Lauder family, of Pittsburgh, Pa., and Greenwich, Conn., to be known as the Anna M. R. Lauder Fund, in memory of the late Mrs. George Lauder. The chair of public health is to be endowed from the gift.

Mr. Richard Beatty Mellon, of Pittsburgh, has endowed a fellowship in internal medicine in the school of medicine, University of Pittsburgh. The fellow will be a resident of a Pittsburgh hospital and will work directly under the professor of medicine, Dr. James D. Heard. In addition, Mr. Mellon has provided funds for the purchase and maintenance of an electro-cardiograph apparatus.

Outlines of a graduate course in aeronautical engineering leading to the master of arts degree have been issued by the Massachusetts Institute of Technology. The aerodynamical laboratory on the new site has already been described. It contains a wind tunnel of sixteen square feet section which can be furnished with currents up to nearly forty miles an hour. Special forms of apparatus have been provided including an aerodynamic balance, a duplicate of that in the National Physical Laboratory at Teddington, England. A full battery of other needed instruments of precision has been installed in the laboratory. The courses will be under the general direction of Professor Cecil H. Peabody, head of the department of naval architecture and marine engineering, and will be conducted by Assistant Naval Constructor, Jerome C. Hunsaker, U. S. N., who is detailed for the service by the secretary of the navy. Courses in dynamics of rigid bodies and theoretical fluid dynamics will be given by Professor E. B. Wilson, Ph.D., professor of mathematics; in explosion motors by Joseph C. Riley, S.B., associate professor of heat engineering; while special lecturers will deliver courses in wireless telegraphy and meteorology.

New appointments and promotions in the Johns Hopkins University are as follows: In the Philosophical Faculty—Alexander G. Christie, M.E., associate professor of mechanical Engineering; Joseph C. W. Frazer, Ph.D., now associate, to be associate professor of chemistry; E. Emmet Reid, Ph.D., associate professor of organic chemistry; William B. Rouwenhoven, Dr.-Ing., instructor in electrical engineering; Walter F. Shenton, Ph.D., instructor in mathematics; Frank A. Ferguson, A.B., assistant in physics. In the Medical Faculty, in addition to the appointment of Theodore C. Janeway, M.D., professor of medicine, Herman O. Mosenthal, M.D., associate professor of medicine, Leonard G. Rowntree, M.D., now associate professor of experimental therapeutics, to be associate professor of medicine, Edwards A. Park, M.D., now associate, to be associate professor of pediatrics, Charles M. Campbell, M.D., now associate, to be associate professor of psychiatry, Hans Lieb, M.D., lecturer in pharmacology, Eli K. Marshall, Jr., Ph.D., now associate in physiological chemistry, to be associate in pharmacology, Benjamin B. Turner, Ph.D., now assistant, to be associate in pharmacology, George J. Heuber, M.D., now assistant, to be associate in surgery, Karl M. Wilson, M.D., now instructor, to be associate in clinical obstetrics, Roy D. McClure, M.D., now assistant, to be instructor in surgery, David M. Davis, M.D., now assistant in pathology, to be instructor in urology.

In the department of anatomy, school of medicine, University of Pittsburgh, Dr. Ralph Edward Sheldon, associate professor of anatomy, for the last three years in charge of the department, has been made professor of anatomy and head of the department. Dr. Davenport Hooker, instructor in anatomy, Yale Medical School, has been appointed assistant professor of histology and neurology.

Dr. Winifred J. Robinson, assistant professor of botany at Vassar College, has resigned this position to accept that of dean of

the Women's Affiliated Colleges of Delaware, at Newark, Delaware.

Albert G. Hogan, Ph.D. (Yale), has been appointed assistant in animal nutrition at the Kansas Agricultural Experiment station, Manhattan, Kansas.

At the University of Indiana Dr. Kenneth P. Williams has been promoted from instructor to assistant professor of mathematics.

Miss Susan Rose Benedict, Ph.D. (Michigan), has been made associate professor of mathematics at Smith College.

DISCUSSION AND CORRESPONDENCE

TYPES OF BIRD GENERA LIMNOTHLYPIS NEW GENUS

Some years ago in discussing the fixing of types for the genera of North American Birds the writer called attention in these columns to the fact that certain names would have to be changed if the principal of "type by subsequent designation" adopted by the International Zoological Congress were adopted. This view was opposed by Dr. J. A. Allen on the ground that in his interpretation of the Code a subsequent designation was not valid if the species designated was already the type of another genus. The point raised was one of such importance that it was placed before the International Commission for an opinion and this has just been rendered and the writer's stand has been endorsed. As the matter is one upon which many systematic workers have been in doubt, it seems desirable to call special attention to the decision.

Incidentally one genus of North American birds is left without a name by the operation of this ruling.

Helinaia Audubon, 1839, contained originally two species, the worm-eating warbler *H. vermivora* (Gm.) and Swainson's warbler, *H. swainsonii* (Aud.). The name has been used universally for the latter but the first designation of a type by Gray fixed it upon the former, and in spite of the fact that this was already the type of *Helmitheros* it thereby becomes the type of *Helinaia*, the latter name being thus a synonym of *Helmitheros* Rafinesque. As no other generic name is available for Swainson's warbler I would propose *Limnothlypis*[1] with *Sylvia swainsonii* Audubon as its type.

Witmer Stone

Academy of Natural Sciences,
Philadelphia

MUTATION

In a recent number of Science Professor Edward C. Jeffrey[1] raises objections to the concept mutation upon the ground that the phenomena in *Œnothera lamarckiana*, which de Vries described as mutation, are not mutation, this species being, as Bateson long ago suggested, a hybrid form. There seems to be about as much cogency in this argument as there would be in the claim that metagenesis is not a true concept because in *Salpa*, the form in which de Chamisso[2] first discovered it, it does not exist.[3]

The distinction between heritable variations (mutations, stable variations, "discontinuous"[4] variations) and non-heritable variations (fluctuating, unstable, "continuous"[4] variations) seems to be clearly established experimentally, and the interpretation of the former as germinal and the latter as somatic in origin, seems to have much in its favor.

Is not Professor Jeffrey's objection somewhat in the nature of a quibble?

Maynard M. Metcalf

A NEW LOCALITY AND HORIZON FOR PENNSYLVANIAN VERTEBRATES

Finds of Pennsylvania vertebrates are always interesting and important and are doubly

[1] λιμνη a marshy lake and θλυπις an ancient bird name.

[1] "The Mutation Myth," Science, XXXIX., No. 1005, April 3, 1914.

[2] A de Chamisso, "De animalibus quibusdum e classe Vermium linneana in circumnavigatione terrae," etc. Fasciculus primus, De Salpa. Berolini, 1891.

[3] W. K. Brooks, "Chamisso and the Discovery of Alternation of Generations," *Zool. Anzeiger*, Jahrg. 5, 1882.

[4] A poor term, for their heredity, not their degree of divergence from the parent stock, is the salient point.

so when the remains are not uncommon and well preserved. One of the writer's students, Mr. Carl Owen Dunbar, has recently discovered a new locality for vertebrates of this period. It is situated near the city of Lawrence and lies at the base of the Lawrence shales. The fossils occur in oblong or spherical siliceous nodules of which nearly one third contain bones and shells of value. Some are filled with small masses of many kinds of organic material and such are interpreted as coprolites, while others contain remains of fishes, crustacea, cephalopods and wood. There are no leaves and few invertebrates. The interesting and remarkable fact connected with the occurrence is the abundance of well-preserved vertebrate fossils. No less than eighteen partial or complete skulls have been collected and such have been found on the occasion of each visit. Three of the skulls show well-preserved casts of the brain. In addition there are many other complete bones, spines and scales.

The description of the vertebrates has been entrusted to Dr. R. L. Moodie, while the invertebrate and stratigraphic phases will be elaborated by Mr. Dunbar and the writer.

W. H. Twenhofel
University of Kansas

EXISTENCE OF CROWN GALL OF ALFALFA, CAUSED BY UROPHLYCTIS ALFALFÆ, IN THE SALT LAKE VALLEY, UTAH

On May 3 of this year, the writer found several typical specimens of alfalfa crown gall, caused by *Urophlyctis alfalfæ* (v. Lagerh.) P. Magnus, in the Salt Lake Valley, Utah. This disease, so far as the writer has noted, has been reported by Smith[1] in California, McCallum[2] in Arizona, and the writer[3] in Oregon. The presence of this disease in Utah may be of considerable importance in explaining many difficulties which alfalfa growers have had in maintaining profitable stands. In looking over the literature I do not note any report of its occurrence in the state of Utah, and, therefore, this note is published in order to record the presence of the disease in another locality. It is not yet known to what extent the disease has been injurious to alfalfa in the Salt Lake Valley, as its distribution has not been investigated.

[1] Science, N. S., Vol. XXX., No. 763, August 13, 1909.

[2] *Experiment Station Record*, Vol. 23, No. 7, December, 1910.

[3] Science, N. S., Vol. XXXVI., No. 928, October 11, 1912.

P. J. O'Gara
Laboratory of Plant Pathology,
American Smelting and Refining Co.,
Salt Lake City, Utah,
May 14, 1914

RELIGIOUS TRAINING AT A UNIVERSITY

The article on this subject on page 722 of Science for May 15 ought not to pass without a protest. The primary function of religion, as most thoughtful men see it, is not worship but the development of right purposes and right ideals in the conduct of life—especially the development of the ideal of service. Nothing stands out more clearly in the teachings of Christ than the thought that worship and ritual are worse than useless unless they contribute to this end.

The statement that "a few are interested in religion, but all of us in education" is, to say the least, misleading. Educational men are apt to be very reticent about religious matters and superficial observers are liable to conclude that their opinions are colorless, but a little inquiry will reveal the fact that a large proportion of both students and faculty are members of Christian churches. In the state university with which I am best acquainted 45 per cent. of the students are members of such churches and 79 per cent. register as adherents of some church. A large majority of the faculty are adherents of churches.

It is true that the fundamental virtues have been long known, as Buckle says, but many of us think that it is also true that there is great need of bringing these virtues forcibly to the attention of men and women at frequent intervals throughout their lives. As our civilization is now constituted the agency which per-

forms this service most effectively for the bulk of our people is the Christian church.

Nearly all Americans will agree that the separation of church and state has been to the advantage of both and that it is not the function of a state university to teach religion. At the same time the faculties of our state universities ought to be in the heartiest sympathy with those who are carrying on religious work among the students and as individuals they should take an active part in work of this character.

W. A. NOYES

UNIVERSITY OF ILLINOIS

SCIENTIFIC BOOKS

Handbuch der Vergleichenden Physiologie. Herausgegeben von HANS WINTERSTEIN. Jena, Gustav Fischer. 1910 et seq. Each part contains about 100 pp. Price unbound 5 Marks.

In SCIENCE, August 12, 1910, p. 211, there appeared a notice of the publication of the earlier parts of Winterstein's comprehensive "Handbuch," begun in 1910. Since that time numerous parts have continued to be issued until at the present moment more than 42 are available. For reasons which are doubtless defensible on the part of the editor and publisher, but not obvious or convincing to the subscribers, the text is being issued in fragments, prepared successively or simultaneously by different authors on quite unrelated topics. In this way a great delay ensues until the individual monographs are completed; and still more time elapses before the volumes can finally be bound in the form intended for them. These are drawbacks which seriously impair the usefulness of any book of reference, especially at a period when the literature of the natural sciences is growing with leaps and bounds.

It would be futile for a reviewer to attempt any detailed reference to a cyclopedic work of this character, even if one individual competent to offer critical opinions upon so great a diversity of topics were available for the task. The best indication of the scope and importance of this scientific-literary undertaking is afforded by the mention of the many well-known biologists and physiologists who are *cooperating in it.* The list of collaborators now includes the following: E. Babak (Prag), S. Baglioni (Sassari), W. Biedermann (Jena), R. du Bois-Reymond (Berlin), F. Bottazzi (Naples), E. v. Brücke (Leipzig), R. Burian (Naples), R. Ehrenberg (Göttingen), L. Fredericq (Liege), R. F. Fuchs (Breslau), S. Garten (Giessen), E. Godlewski (Krakow), C. v. Hess (Munich), J. Loeb (New York), E. Mangold (Freiburg), A. Noll (Jena), H. Przibram (Vienna), J. Strohl (Zürich-Naples), R. Tigerstedt (Helsingfors), E. Weinland (Erlangen), O. Weiss (Königsberg), H. Winterstein (Rostock).

Among the completed volumes is one (III. 2) upon the metabolism of energy and the physiology of changes in form, in which chapters upon animal heat (Tigerstedt), the production of electricity (Garten), the production of light (Mangold), animal form (H. Przibram), and reproduction (Godlewski, Jr.) are included. Volume IV. deals with the physiology of irritability, conductivity, etc.—phenomena of the nervous system. For this a chapter on tropisms has been prepared by Jacques Loeb. The first half of Volume II. is devoted to the classic compilation of Biedermann upon the ingestion, alimentation and absorption of food by the invertebrates. This alone is a most extensive monograph, the exhaustive character of which is represented in nearly a thousand pages, with 200 illustrations and about 1,200 references. Volume I. is to deal with the fluids and tissues, and with the comparative physiology of respiration.

The foregoing comments give a very imperfect idea of the contents of many hundreds of pages of illustrated text—an invaluable cyclopedia in a field which has hitherto not afforded any such elaborate systematic compilation.

LAFAYETTE B. MENDEL

SHEFFIELD SCIENTIFIC SCHOOL,
YALE UNIVERSITY

Kristallberechnung und Kristallzeichnung. By B. GOSSNER. Leipzig und Berlin, Wilhelm Engelmann. 1914. Pp. viii + 128;

1 plate; 109 figures in text. Price, 8 Marks.

During the last fifteen years the older rather tedious and somewhat intricate methods for the calculation and drawing of crystals have been greatly simplified by the contributions of Goldschmidt, Penfield, Wulff and Hutchinson especially. The purpose of the present text is to bring together these various methods in a clear and concise form in a single treatise.

The general part of the book comprises sixty-six pages and includes a discussion of the stereographic, gnomonic and linear projections and the development of general formulas for the calculation of crystals. The use of the protractors of Hutchinson and Penfield are described at length, as is also the stereographic net of Wulff. All possible cases of crystal-calculation are then taken up fully in a discussion extending over twenty pages.

The special part of the text, consisting of sixty-one pages, is devoted (*a*) to the application of the methods of crystal-calculation, examples being introduced for each system; and (*b*) to crystal-drawing. Here the methods for the drawing of crystals directly from stereographic and gnomonic projections are given first. These are followed by those involving the use of the axial cross for the projection of simple and twinned crystals.

The treatment throughout the book is concise but clear, and illustrated with 109 diagrams. There is also a bibliography of the most important texts and papers on the subject. The book is a valuable contribution and all advanced students of geometrical crystallography should have access to it.

EDWARD H. KRAUS

MINERALOGICAL LABORATORY,
UNIVERSITY OF MICHIGAN

The Electrical Conductivity and Ionization Constants of Organic Compounds. By HEYWARD SCUDDER, B.A., B.S., M.D. New York, D. Van Nostrand Co. 1914. Pp. 568. Price $3.00.

In the words of the author, "the object of this book is to present as far as lies in my power a bibliography of all the measurements of the ionization constants and the electrical conductivity literature between the years 1889 and 1910 inclusive, together with the values of the ionization constants, and certain values of the electrical conductivity measurements. Qualitative work is also included. . . . From 1910 to the beginning of 1913, important corrections that have come to my notice have been inserted."

As to arrangement: "The book is divided into a set of tables arranged according to the names of the compounds, containing all the data that may be given with a bibliography of all references to each compound; a formula index to the compounds; a bibliography arranged according to the names of authors; a subject index to certain subjects; and a journal list giving the names of all journals examined with the number and date of the last volume examined."

The first set of tables will show the values, if known, of the specific conductivity of the pure substance; the ionization constant; the conductivity in aqueous solution; the conductivity in solvents other than water; the conductivity under various conditions as to temperature and pressure and in various mixtures; the conductivity of the salts at many different temperatures and in many different solvents.

The vast amount of labor that the author must have expended upon this compilation will be greatly appreciated by workers in this field of physical chemistry. As the variation in the expression for the dilution law lately suggested by Kraus and Bray is likely to awaken a new interest in conductivity values and ionization constants, the book should prove to be of much service.

The list of errata is wonderfully small considering the nature of the work.

E. H. ARCHIBALD

NOTES ON METEOROLOGY AND CLIMATOLOGY

"THE Rainfall of California," by Professor Alexander McAdie (Univ. Calif. Geogr. Pub., Vol. 1, No. 4, pp. 127–240, Pls. 21–28). This

recent publication is a thorough treatment of the complex rainfall conditions of California. The chief factors controlling rainfall there are centers of action ("hyperbars and infrabars"), prevailing surface drift, ocean effect, topography and ocean currents (including upwelling cold water[1]). The influence of the positions of the centers of action may be summed up in this general law: "Typical wet winters on the California coast occur when the North Pacific low overlies the continent west of a line drawn from Calgary to San Francisco. Typical dry winters are associated with a westward extension of the continental high to the coast line and a retreat of the Aleutian low to the northwest." The prevailing surface drift of the atmosphere is northwest in summer but southerly and westerly in winter. In winter, these winds from the Pacific Ocean supply ample moisture for rainfall where topography causes them to rise. The complexity of ocean currents and ocean temperatures on this coast may locally affect rainfall.

The rainfall resulting from the combination of these factors is moderate to heavy (more than 2,000 mm.) on the west slopes of the coast ranges and Sierra Nevadas, but light on the east side. On the west slopes of the Sierras from the floor of the Great Valley to an altitude of 1,500 meters, the rainfall increases on the average about 75 mm. per 100 meters of ascent. Above 1,500 meters, the rainfall seems to decrease slightly with altitude. The rate of decrease of rainfall with decreasing altitude down the east slope is variable, depending on the height and the rainfall of the mountain crest. On the line of the Central Pacific Railroad, the rainfall decreases 147 mm. per 100 meters of descent. In southern California, the zone of maximum rainfall is much higher, and the rate of increase with altitude is about 50 mm. per 100 meters up to 2,500 m. The details of California rainfall are shown in comprehensive tables.

Parts of California are subject to excessive rains. These rains are of the cloudburst type in the drier areas. In the wetter portions, the excessive rains are less intense but of greater duration. A large table of excessive precipitation is given. In the high mountains, snowfall, so important for irrigation and water-power, is very heavy. Special attention is paid to the snowfall and melting of snow on the ground at Summit (alt. 2,138 m.). The average annual snowfall there is more than 1,000 cm. Tamarack, a station at 2,438 m. altitude, has an even heavier snowfall. In the table, a snowfall of 2,260 cm. is indicated in the winter of 1906–07. The record maximum for any month was 998 cm. in January, 1911. The rainfall of San Francisco is treated in detail at the end of the memoir.[2]

[1] This upwelling is most marked in summer and is caused by the strong northwest winds of the great North Pacific high: G. F. McEwen, "Peculiarities of the California Climate," *M. W. R.*, January, 1914, pp. 14–23. See also, W. G. Reed, "The Japan Current and the Climate of California," *M. W. R.*, February, 1914, pp. 100–101.

[2] *Cf.* also W. G. Reed, "Variations in Rainfall in California," *M. W. R.*, November, 1913, pp. 1785–1790.

THE MONTHLY WEATHER REVIEW

THE *Monthly Weather Review* with the January, 1914, issue has reverted to the more or less popular form it had until July, 1909. The material is classified under the heads (1) Aerology, (2) General Meteorology, (3) Forecasts and General Conditions of the Atmosphere, (4) Rivers and Floods, (5) Bibliography, (6) Weather of the Month. Some of the articles in the January and February numbers are briefly considered below.

Lorin Blodget's "Climatology of the United States": An Appreciation. By Robert DeC. Ward. (Pp. 23–27.) This great work, a pioneer in its field, receives deserved praise and attention in this article. Professor Ward quotes many of the happy and vivid descriptions of the climate of the United States and its human effects which are as valuable to-day as ever. Evidently little has been added to our knowledge of the general conditions and controls of the climates of the United States in the last fifty years. The advance has been chiefly in the study of the details.

"The Meteorological Aspect of the Smoke

Problem." By H. H. Kimball. (Pp. 29–35.) On account of the usual smoke-blanket over cities, sunlight is diminished in intensity, and radiation is hindered. The effect is greatest in winter and in the early morning when the air circulation is slowest. The duration of fogs is increased by the presence of smoke because of the protection against sunlight and because of the actual coating of the particles with oil. On account of smoke and fog, higher minima and lower maxima temperatures occur in cities than in the surrounding country.

"The Effect of Weather upon the Yield of Corn." By J. Warren Smith. (Pp. 78–93.) The rainfall at the time of flowering of the corn and shortly thereafter (generally, the four weeks beginning the middle of July), is a great factor in determining the success or failure of the crop. In this period a few moderately heavy rains are most favorable. The rate of growth of the corn corresponds closely to the maximum temperatures. There are maps showing corn-acreage, dates of planting and harvesting, and the periods between these dates.[3]

ANTARCTIC METEOROLOGY

SOME of the meteorological results of Scott's last expedition are reviewed by Dr. J. v. Hann in the *Meteorologische Zeitschrift*, February, 1914 (pp. 62–67). Also a short review of an article by Prof. W. Meinardus is to be found in the *Scientific American*, April 25, 1914 (p. 347). Cape Evans (77° 35′ S., 166° 32′ E.) at the foot of the Ross Barrier, Cape Adare (71° 18′ S., 170° 9′ E.) on the west side of the Ross Sea, and Framheim (78° 38′ S., 195° 30′ E.) on the ice sheet not far southeast of the Ross Sea, are stations from which observations of some length are available. Winds of low velocity are most frequent for these three stations,—particularly for Framheim. The stillness of the atmosphere at Framheim is favorable to excessive cooling of the lower air. As a result, the annual temperature there was —24.4° C. (10 mo. obs., 2 mo. interpolated). The summer temperature was —7.3° and the winter temperature —37.8°. Cape Evans near the base of the Ross Barrier is subject to west-wind blizzards in which the wind is extremely gusty. Simultaneously, Cape Adare, a short distance north, experiences light southwest winds. This anomaly is apparently the result of the convectional circulation due to a large difference in temperature between the air at the top of the Ross Barrier and that over the Ross Sea. The dense cold air, thus forced over the cliff, makes an air-fall of great velocity (this phenomenon is known as the "bora" in Europe).

Atmospheric electricity is at a maximum in summer and at a minimum in winter, the reverse of the rule in middle latitudes. Nitric acid in rain(snow)-water is about the same in amount as that found in Europe. This fact is opposed to the idea that thunderstorms are largely responsible for the nitric acid found in rain water. The carbon dioxide content of air samples was 0.0205 per cent.—a striking contrast to the usual 0.03 per cent. of other parts of the earth. The samples from which these determinations were made were collected by Mr. R. E. Godfrey, of the Charcot Expedition, 1909–1910.[4]

NOTES

DR. HERGESELL, head of the Meteorological Institute of Strassburg, has been appointed to succeed Dr. Assmann as director of the Aeronautical Observatory at Lindenberg.

ON January 6, 1914, Dr. Nils Ekholm succeeded Dr. H. E. Hamberg as director of the Swedish Statens Meteorologiska Centralanstalt.

OBSERVATIONS of Messrs. Okada, Fujiwhara and Maeda indicate that thunderstorms may produce seiches in lakes. The change of pressure, impulsive action of the wind and rainfall seem to be the principal causes.[5]

[3] Detailed studies of plant growth as related to soil and meteorological conditions are in the course of preparation for an extensive atlas of American agriculture, under the direction of Mr. O. E. Baker, of the Bureau of Plant Industry.

[4] *Scientific American*, April 11, 1914, p. 304.

[5] *Nature*, April 30, 1914, p. 222.

THE meteorological service of India is beginning aerological work with balloons sondes.

AN extreme minimum temperature of — 91.9° C. was recorded with a ballon sonde on November 5, 1913, over Batavia, Java. Another ballon sonde brought down a record of — 90.9° at 17 km. altitude on December 4. Above this the temperature rose to — 57.1° at 26 km.[6]

PYRHELIOMETRIC observations obtained from ballons sondes in California last summer at altitudes of 10 to 13 km. indicate a lower solar constant of radiation than is obtained from observations at the earth's surface after transmission corrections have been added. Although a maximum altitude of 33 km. was reached, no observations were secured above 13 km. because of the freezing of the mercury.[7]

THE unpublished papers of the International Meteorological Congress held at Chicago in 1893 are now appearing in the *Monthly Weather Review*.

A CONFERENCE of observers and students of meteorology and allied subjects will be held in Edinburgh, September 8 to 12, 1914.[8]

CHARLES F. BROOKS
HARVARD UNIVERSITY,
May 18, 1914

SPECIAL ARTICLES

A CULTURE MEDIUM FOR THE TISSUES OF AMPHIBIANS

IN the course of some experiments on the culture *in vitro* of tissues from various amphibians, considerable difficulty was encountered in using blood plasma as a culture medium on account of its very rapid coagulation. When working with the tissues of the frog or of tadpoles it was more convenient to use lymph taken directly from some of the subcutaneous lymph spaces. Preparations in lymph may frequently be made before coagulation occurs, but the lymph tends to become too watery for use a short time after the frog is killed, so that only a small quantity is available from any one animal. In most urodeles the scarcity of available lymph prohibits its employment, so that plasma was at first depended on almost entirely for a culture medium.

There is little outwandering or outgrowth from the tissues of either the embryos or the adults of amphibians unless the surrounding medium is of more or less solid consistency. Amphibian tissue will live for weeks in blood serum or even in Ringer's solution, but the cells do not often grow or wander away from the rest of the mass unless they come into contact with a substance that evokes a thigmotactic response. In searching for a convenient substitute for blood plasma the endeavor was therefore made to find a medium which would remain fluid while being used, but which would solidify to about the consistency of blood clot afterwards. After some experimentation it was found that a mixture of equal parts of blood serum and a two per cent. solution of Grübler's nutrient gelatine afforded a substitute that was very successful.

The preparation of the mixture is easy. Blood drawn from the heart is stirred with a fine glass rod and the coagulum removed. The blood is then centrifuged to remove the corpuscles, and the clear serum mixed with an equal quantity of a two per cent. solution of gelatine. The gelatine solution is previously boiled and precautions are taken to prevent contamination of any of the ingredients of the medium with bacteria. I have used the mixture after it had been kept for several days, and found it to be practically as good a culture medium as when perfectly fresh.

The mixture becomes fluid when warmed slightly and remains fluid for an hour or more after being cooled to ordinary room temperature. I commonly keep it in small tubes of glass, and by rubbing the tubes briskly with the fingers sufficient heat may be generated to cause the gelatine to liquify. Should the supply of culture medium solidify while one is putting up preparations, it is only necessary to warm it slightly to keep it fluid for an hour or more longer.

[6] *Nature*, March 5, 1914, pp. 5–6.

[7] C. G. Abbot, *Scientific American*, April 4, 1914, p. 278.

[8] See *Nature*, February 12, 1914, p. 667.

Making preparations of tissues is greatly facilitated by the use of this medium, and the comparatively constant composition of the mixture renders the results obtained through its use more uniform than those secured by the employment of lymph or plasma. The implanted cells get what very nearly corresponds to their natural food in the serum of the blood, and the gelatine, while apparently acting in no way injuriously to the cells, affords a means of appealing to their thigmotactic proclivities that is ordinarily supplied by the fibrin of clotted plasma.

The outgrowth of epithelium in this medium is remarkable. In some cases it has been over twenty times the superficial area of the implanted tissue. As a rule the tissues thrive better than in plasma or lymph. It is comparatively easy to subculture the tissues, since the gelatine dissolves in Ringer's solution, and by washing the preparations in this fluid they may be readily freed, and then transferred to a fresh culture medium. I have transferred pieces of epithelial tissue several times in succession, and kept them thriving for three months. Cell divisions have been repeatedly seen in epithelial cells in this medium. In a piece of tissue put up on February 17 and changed to fresh culture fluid three times afterwards, I observed several mitotic figures in epithelial cells on April 8, fifty days after the preparation was made. The chromosomes could be seen with great distinctness in the living material. In one cell first seen in the prophases of division, the chromosomes were seen to align themselves in the equatorial plate, then to be drawn apart, and finally to become constituted into the two daughter nuclei; at the same time the constriction in two of the cell body could be distinctly followed. Over a dozen other mitotic figures in various stages were observed in the same piece. The preparation had been washed in Ringer's solution and transferred to new culture medium a few days previously, after which it had taken on a new lease of life. The division figures were all seen in a transparent sheet of epithelium that had spread out in contact with the cover slip supporting the hanging drop culture.

S. J. HOLMES

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ON THE CHEMICAL NATURE OF THE LUMINOUS MATERIAL OF THE FIREFLY

OUR knowledge of the chemistry of light production by organisms may be summed up in the statement that phosphorescence is due to the oxidation of some substance formed in the cells of the animal. As with other oxidations, both water and oxygen must be present. If either water or oxygen are absent the photogenic substance will not be used up by oxidation. Luminous tissues if dried rapidly may be ground up and preserved indefinitely, and at any later time, if moistened in the presence of oxygen, will phosphoresce. This old and important discovery makes the investigation of the chemical nature of the luminous substance relatively easy. The dried powder of the luminous organ may be extracted with: (1) Oxygen-free watery solvents, or (2) water-free solvents (as ether, chloroform, etc.) with or without oxygen.

The earlier workers supposed the photogenic material to be phosphorus or phosphine. These views require no comment to-day. Later suggestions have been that the substance is a fat, an albumin, a lipoid (lecithin), a nucleoalbumin or a lecithoprotein (phosphatid). It is obviously desirable to know whether the substance is fat-like or protein in nature. The fact that phosphorescence ceases as soon as the moist luminous material is heated to 100° proves nothing, for, like organic oxidation in general, an oxidizing ferment is probably involved, and it is this oxidase which may be destroyed on heating.

I can state definitely that the "luciferin" of the common fire-fly is not a true fat or any fat-like body such as lecithin. The dried material may be extracted with anhydrous ether and the ether extract evaporated to dryness. On adding water or a watery extract of luminous organ (to add an oxidizing enzyme) or potato juice (to add an oxidase) to the residue no phosphorescence took place; on adding water to the original ether extracted

material brilliant phosphorescence occurred. The same results were obtained with anhydrous chloroform, ethyl alcohol, acetone and carbon tetrachloride. The material is therefore insoluble in fat solvents.

It is most likely a protein but belongs among the proteins insoluble in water. By means of a specially constructed apparatus I was able to extract with oxygen-free distilled water and to filter the extract in an oxygen-free space. On admitting air the filtrate did not glow, but the filter paper showed innumerable bright dots. The granules of luminous substance are therefore insoluble in water. A lack of material has prevented extraction with other protein solvents, salt solution, acids and alkalies.

E. Newton Harvey

Princeton, N. J.,

THE AMERICAN CHEMICAL SOCIETY. II

DIVISION OF FERTILIZER CHEMISTRY

J. E. Breckenridge, Chairman

F. B. Carpenter, Secretary

Chairman's Address: *Chemistry an Important Factor in the Fertilizer Industry:* J. E. Breckenridge.

The Preparation of Neutral Ammonium Citrate: Ermon D. Eastman and Joel H. Hildebrand.

The proposed method depends on the preparation of a standard sodium phosphate solution of known hydrogen ion concentration and the comparison of the color produced by rosolic acid in this solution with that produced by the same indicator in the ammonium citrate solution to be tested. The normal ammonium citrate solution is shown by its hydrogen ion concentration to be slightly acid and the authors have therefore adopted the neutral rather than the normal solution.

A Comparison of Neutral Ammonium Citrate with Sodium Citrate and N/10 Citric Acid: Paul Rudnick, W. B. Derby and W. L. Latshaw.

Sodium citrate proposed by Bosworth (2) can be used as a substitute for the official neutral ammonium citrate, but N/10 citric acid obviates difficulties due to highly concentrated solutions, such as slowness in filtration, etc., and gives results which are in excellent agreement with those obtained by the official neutral ammonium citrate.

The Separation of Organic Nitrogen from Mixed Fertilizers: C. H. Jones.

The method recommended depends on separation by gravity in carbon tetrachloride. Tables giving the behavior of various fertilizer ingredients and their availability by the alkaline permanganate method are included.

Separation of Phosphoric Acid from Lime: F. K. Cameron.

A discussion of the solubility curves of potassium and ammonium phosphates and their applications to practical problems.

Separation of Potash from Kelp (lantern): F. K. Cameron.

An illustrated description of the kelp beds and the methods of harvesting so far developed.

DIVISION OF PHARMACEUTICAL CHEMISTRY

F. R. Eldred, chairman

A. P. Sy, Secretary

Methods of Analysis of the Forthcoming Pharmacopœia: H. W. Wiley.

Seasonal Variation in the Composition of the Thyroid Gland: Atherton Seidell and Frederic Fenger.

The experiments upon this subject embracing the period August, 1911, to August, 1912, have been continued for another one-year period beginning December 1, 1912. The evidence for the seasonal variation in iodine content of the thyroid gland has been confirmed, and additional data obtained, showing that a regular change of phosphorus and ash, varying inversely with the iodine, occurs. In regard to the fresh weight of the glands, the results indicated a regular seasonal change in the case of the beef and sheep, but not with the hog. The results demonstrate the practicability of a standard of 0.2 per cent. iodine in commercial desiccated thyroids.

Some Peculiarities of Present Food and Drug Laws: Frank O. Taylor.

Notes on the Determination of Antipyrine: George D. Beal and Duane T. Englis.

Antipyrine and caffeine can be easily extracted by chloroform from an aqueous solution three-fourths saturated with sodium chloride. If the liquid contains vegetable extractives, the extraction can be effected without emulsification by first precipitating the coloring matter, resins, etc., with lead acetate. The antipyrine may be titrated in the presence of caffeine by Bougault's[1] method,

[1] *Jour. Pharm. Chem.*, [6], 1, 161, 11, 97.

using an alcoholic solution of iodine, and adding at the same time an alcoholic solution of mercuric chloride, to take up the liberated hydriodic acid. One gram of antipyrine = 1.351 grams of iodine. The authors find that as effective a method consists in the substitution of an ordinary N/10 iodine solution for the alcoholic iodine solution, titrating in the presence of alcohol, and adding sufficient alcoholic mercuric chloride to combine with the hydriodic acid liberated and in addition enough to combine with the potassium iodide in the N/10 iodine solution. The results are accurate and the endpoint is distinct.

Further Notes on Lloyd's Reagent for Alkaloids: SIGMUND WALDBOTT.

In precipitating quinine from aqueous solutions of quinine bisulphate by means of Lloyd's reagent,[2] the filtrate upon evaporation yields crystals of calcium sulphate, due to the calcium contents of the reagent. When the CaO is completely removed by hydrochloric acid, the modified acid-free reagent, upon precipitating quinine from quinine bisulphate, yields free sulphuric acid in the filtrate. This demonstrates that the affinity of the reagent for alkaloid is strong enough to tear asunder the quinine bisulphate molecule.

Estimation of Phenacetin and Acetanilide in Admixture: W. O. EMERY.

Estimation of Antipyrin: W. O. EMERY AND S. PALKIN.

Estimation of Caffeine and Antipyrin in Admixture: W. O. EMERY AND S. PALKIN.

Estimation of Phenacetin and Salol in Admixture: W. O. EMERY, C. C. LEFEVRE AND G. C. SPENCER.

A Method for the Estimation of Podophyllum Resin: W. M. JENKINS.

Commercial Papain and its Testing: H. M. ADAMS.

Some Observations on the Leach Test for Coumarin: WILLIAM G. GAESSLER.

Digitalis Ash: CHARLES T. P. FENNEL.

The recognized importance of mineral constituents in plants, the elements of plant development—their equal importance to plant life—classification as air and soil groups—products of plant life—products of physiological processes not in the ash—foundation substances of the soil—the needs of proper soil to fit the plant for specific purposes—medicinal plants—history of the method of use—juices direct—watery extracts, alcoholic extracts—isolation of so-called active constituents—variations in therapeutic action—the preexistence and the generation of active constituents by manipulation of processes of extraction—digitalis and other plants—the ash—constituents—peculiarities—elementary decay—eka silicon—radioactive matter in rocks and soils—effect on plant life—experimentally.

[2] *Cf. Jour. Amer. Chem. Soc.*, June, 1913.

The Estimation of Morphine: H. M. GORDIN.

The Estimation and Variability of Alcohol in Galenicals: L. F. KEBLER.

Results of the Examination of Some Medical Agents in the District of Columbia: L. F. KEBLER.

Extraction of Morphine from Aqueous Solution: H. BUCHBINDER.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

Geo. P. Adamson, Chairman

S. H. Salisbury, Jr., Secretary

Volumetric Determination of Sulphur in Iron Ore: L. SELMI.

The method is based on the ignition of the ore in a current of hydrogen and in presence of zinc (and animal charcoal if sulphates of lime and barium are present). The reduction is prolonged for about twenty minutes and the heat discontinued and the furnace cooled rapidly at room temperature while the hydrogen is kept going through the furnace. When room temperature is attained the reduced ore is transferred to an evolution flask and the H_2S evolved as in the case of iron and steel. Accurate results have been obtained in less than one hour, and this method is especially adapted for the determination of low sulphur in iron ores. The apparatus required is a fused silica tube, heated either by electricity or gas, a Kipp hydrogen generator and three gas washing bottles. On a number of determinations by this method I obtained the following sulphur results on the Bureau of Standards magnetite ore (standard .025 per cent.): .025, .026, .025, .024, .027, .025.

Pitot Tubes for the Measurement of Gas Velocities: ANDREW M. FAIRLIE.

Numerous instances are cited in which some method of accurately measuring gas velocities is needed. Errors appearing in recent publications on this subject are corrected. As a result of recent work, a type of Pitot tube is indicated, which chemical engineers may select and use, under certain conditions, with confidence. Features requiring further investigation are pointed out.

A Comparison of Various Modifications of the Kjeldahl and Dumas Methods for the Determination of Nitrogen in Coal and Lignite: A. C. Fieldner and C. A. Taylor.

The Mechanism of the Reaction between Phenolic Bodies and Active Methylenes: L. V. Redman, A. J. Weith and E. P. Brock.

Fluorescence of Petroleum Oils: Benjamin T. Brooks.

Engler and others consider that fluorescence of petroleum oils is due to colloid matter suspended or emulsified with the oil. Experiments of the author with the ultramicroscope showed that this can not be the case. Such fluorescent oils give no indication of electrophoresis. The fluorescent substance or substances readily form sulphonic acids, which are soluble in water and may be separated from the acid sludge tar obtained on treating with concentrated sulphuric acid. In general oxidizing agents destroy the fluorescent substance, but the action of nitro compounds as "deblooming" agents is purely physical. If an oil is debloomed by nitrobenzol, for instance, removal of the latter by shaking out with alcohol restores the fluorescence. The nitro group apparently does not have to be introduced into the molecule of the fluorescent substance itself in order to "cover up" the fluorescence. Other compounds employed as solvents, such as amyl alcohol, carbon bisulphide, aniline benzol, etc., appear to affect the fluorescence of petroleum oils in much the same way as Kauffman found for terephthalic acid esters. Distillation of crude petroleum at atmospheric pressure yields more highly fluorescent distillate than the same oil distilled in vacuo. The fluorescent substances therefore result from pyrogenic decomposition in much the same way as the fluorescent hydrocarbons obtained in the distillation of coal.

The Manufacture of Gasoline from Heavy Petroleum Oils (lantern): B. T. Brooks, R. F. Bacon and C. W. Clark.

Some Economic Phases of the Gasoline Supply: Benjamin T. Brooks.

Curves are given showing the rate of increase in the consumption of gasoline and its production from crude petroleum. Production of gasoline or motor spirit may be increased by (1) cracking heavier hydrocarbons, (2) employing motor spirit of lower Beaume gravity than now customary, (3) casing head gasoline. It is shown that benzol is not and probably can not be manufactured in sufficient quantity to meet the growing demand for motor fuel. Alcohol may be used to some extent should the price of gasoline exceed 40 cents per gallon. Alcohol is not now used for this purpose in England, where gasoline has been selling for approximately 40 cents for the last two years.

Absorption of Caustic Soda by Cellulose: W. D. Bancroft.

The Stability of Rosin at Slightly Elevated Temperatures.—A Correction: Chas. H. Herty and H. L. Cox.

The Chemists' Club: William L. Dudley.

The Chemist, a Growing Factor in Merchandizing: A. V. H. Mory.

The old rule of trade, "Let the buyer beware," is rapidly giving way to the rule, "Let the seller beware." The small consumer never has been able to more than roughly inspect the character of his purchases. The merchant has always been better able to afford a thorough inspection. Now that the law is placing the responsibility on him, the merchant is more and more under the necessity of turning to technical aid. There is also a natural law, making rigid inspection on the part of the merchant a good business investment, viz.: The satisfied customer is the basis for permanent merchandizing success, and satisfaction can come only through insuring quality and accuracy in description. A new field, therefore, which may be called laboratory inspection of merchandise, is rapidly growing, and is likely to receive great impetus through the enactment of general commodity laws.

The Method of Analysis of Gasoline: G. W. Gray.

The Method of Testing Illuminating Oils: G. W. Gray.

Coal Ash in Some Unusual Phases: S. W. Parr.

A Thermoelectric Method of Determining the Purity of Platinum Ware: G. K. Burgess and P. D. Sale.

As illustrated for crucibles, this method consists in measuring the E.M.F. across the crucible rim, one side being heated and the other not. A fine wire (0.2 mm.) of pure platinum is arc-soldered to one side and a Pt, Pt-Rh junction to the other. The iridium content or platinum purity of the crucible may be very exactly determined by the E.M.F. developed between the Pt wires and the temperature as measured by the Pt, Pt-Rh thermocouple, using an ordinary pyrometer galvanometer. The Bureau of Standards is prepared to test the platinum purity of crucibles by this method.

A Nevada Oil Shale: Chas. Baskerville.

The Metallography of Malleable Iron: J. Culver Hartzell.

A brief survey of the field with special reference to the difficulties encountered in correlating the chemical and structural analyses of malleable cast iron in the hard and in the annealed states.

The Pyrometer in the Assay Muffle: FREDERIC P. DEWEY.

Standing alone, by itself, a pyrometer reading has absolutely no value as a control of assay operations in a muffle or as a guide to the assayer in carrying on such operations. The reasons for this are varied and complex. In the first place, the temperature that controls the success of the operation is that of the lead button undergoing oxidation. At present we have no means of learning this temperature under practical working conditions, so that some suitable place must be selected within the muffle for the location of a pyrometer. Unfortunately, however, and in the second place, there is absolutely no approach even to a fixed relation between the pyrometer reading at any given point available and the temperature of the oxidizing button. The oxidation of the lead supplies much heat to the button, but its effect upon the pyrometer is negligible. One factor governing the amount of heat utilized by the button is the rate of oxidation of the lead, and this in turn is, within wide limits, largely influenced by the passage of the air over the button, so that to fully utilize and apply the pyrometer reading we must also know the height of the barometer and the effect of variations in the barometer readings upon the draft of the particular muffle under consideration. Further and most important, from a practical standpoint, is the freedom of entrance for the air to the muffle. In other words, by manipulating the door or stopper of the muffle, widely varying differences between the button temperature and the pyrometer reading may be produced. The effect of the door condition is twofold. It affects the supply of air to the button and also the actual temperature of the bottom of the muffle on account of varying amounts of air that have to be heated there in passing through the furnace. Finally, the relation of the position of the button within the muffle to that of the pyrometer is vital. Therefore, to intelligently utilize any stated pyrometer reading it is essential to have exact information upon a variety of other conditions surrounding the operation. However, the pyrometer is a good general guide to temperature conditions, but the man who depends upon it entirely will not be a good cupeller.

Note on a Cause of Spontaneous Combustion in Coal Mines: HORACE G. PORTER.

Graphical Studies of the Ultimate Analyses of Coals: OLIVER C. RALSTON.

Plotting the ultimate analyses of coals, in terms of carbon, hydrogen and oxygen, on the "ternary diagram" as modified to compensate the greater errors involved in the term "oxygen," has given results of surprising concordance. Some thousands of analyses are plotted with different objects in view. Classification into anthracite, semi-anthracite, semi-bituminous, bituminous, etc., is very easy, as each of these falls in a certain area of the diagram. The effects of oxidizing coals, heating them, fractionating them mechanically, chemically and physically, etc., are studied with the revelation of many interesting relations. Methods are given of judging with fair accuracy the calorific value, volatile and moisture of the coals in different parts of the diagram. All the analyses in Bull. 22 of the Bureau of Mines are plotted and constitute an interesting criticism on the accuracy of work done there and seem to fall within probable error, as near as such an error can be calculated on such a complex substance as coal. This paper will be published by the Bureau of Mines.

Osage Orange, Its Value as a Commercial Dyestuff: F. W. KRESSMANN.

It has long been known in the southwest that the wood of the Osage orange tree contains a dyestuff that would give a more or less fast yellow color.

An examination of the wood from Texas showed that it not only contains moric acid and morintannic acid, the same as fustic wood, but also that the dyeing principles are present in amount to be commercially valuable. A comparative series of dyeing experiments made with fustic and Osage orange wood and extracts showed the latter to be of equal value with fustic in regard to depth of colors produced, the amount of extract, the character of the dyeing and fastness to light, weather, washing, etc.

Some Preliminary Experiments on the Hydrolysis of White Spruce, etc.: F. W. KRESSMANN.

On hydrolyzing spruce with dilute sulphuric acid solutions it was found that the yields of sugar increased rapidly with increasing pressures of digestion up to a pressure of 7½ atmospheres, above which point the decrease was quite rapid. The reaction is probably reversible, since the large decrease can not be accounted for entirely by sugar decomposition.

About 70 per cent. of the total sugar produced

is fermentable. Yields of 23 gallons of 95 per cent. alcohol per dry ton of wood have been obtained. Acetic and formic acids are also products of hydrolysis, the yield of the former being constant (about 1.42 per cent.) over a wide range of cooking conditions. The yield of formic acid increases with increasing severity of cooking conditions. The acetic acid and part of the formic acid are probably due to hydrolysis of acetyl and formyl in the lignin complex, while part of the formic acid results from sugar decomposition.

A Method for the Rapid Quantitative Analysis of Bronze and Brass, Pb, Cu, Sn, Sb, Fe and Zn: Richard Edwin Lee, John P. Trickey and Walter H. Fegely.

The authors of this paper have made a careful experimental survey of the majority of the better-known methods for the quantitative analysis of brass and bronze, but have failed to find a method which was both rapid and accurate. It is pointed out that such a method is needed for "control" work, as well as for routine work in testing laboratories. The authors have then formulated a scheme for the quantitative analysis of these alloys which is apparently very rapid and at the same time meets the usual requirements in regard to accuracy. It is claimed that the complete analysis of three different bronzes containing Pb, Cu, Sn and Zn can be completed inside of two hours. Each determination is made on a separate portion of the sample. The series of test experiments incorporated in the paper indicates that the methods permit of a wide application. The maximum error of any determination in any series is .15 per cent.; the average error, however, is much less.

A Method for the Rapid Quantitative Analysis of Babbitt Metals, Pb, Cu, Sn and Sb: Richard Edwin Lee, John P. Trickey and Walter H. Fegely.

This paper contains a report of a rapid and accurate method for the quantitative analysis of Babbitt metals. The chief objection urged by the authors against the majority of the methods that have been proposed is that they require too much time for their execution. In the method reported, each determination is made from a separate portion of the sample, with the exception of Sn, which is determined volumetrically in the same solution in which Sb is determined. The maximum error is .15 per cent.; the average error, however, is less. Demorest's method has been articulated with the proposed method so that an alloy close to the limit of the specification may be checked by a different although longer method. The methods have been tested in two large commercial laboratories for several months and found satisfactory.

The Composition and Testing of Printing Inks: J. B. Tuttle and W. H. Smith.

The Determination of Carbon in Iron and Steel by the Barium-Carbonate Titration Method: J. R. Cain.

The apparatus used for filtration, difficulties and sources of error, with means of obviating these, are described, and details are given of a series of experiments showing the special application and the degree of accuracy of the barium carbonate titration method when applied in steel analysis.

Determination of Ammonia in Illuminating Gas: J. D. Edwards.

This paper is a summary of the results of a brief investigation of the apparatus and methods employed for the commercial determination of ammonia in illuminating gas. The five forms of apparatus studied gave results, when properly operated, well within the limits of accuracy required for this determination either for commercial control work or for the purpose of gas inspection. Suitable indicators have been recommended and precautions to be observed in the operation of the different forms of apparatus have been pointed out.

The Iodine Number of Linseed and Petroleum Oils: W. H. Smith and J. B. Tuttle.

The iodine values of raw, boiled and burnt linseed oils, and petroleum oils, were determined by the Hanus method, varying widely the amounts of oil and iodine used, and the time of absorption. A study of the effect of temperature on the iodine value was made. It is shown that in order to obtain concordant results, a prescribed procedure must be followed, and exact conditions stated.

Chemical Jurisprudence: Louis Hogrefe.

Report of the Committee on Alum Specifications.

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, Chairman

Dorris Whipple, Secretary

The Influence of Temperature in the Physical Testing of Rubber Goods: T. L. Wormeley and J. B. Tuttle.

Review of Report of Joint Rubber Insulating Committee: Dorris Whipple.

Charles L. Parsons,
Secretary

(*To be continued*)

SCIENCE

Friday, July 10, 1914

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

EDUCATIONAL COSTS

I

In the treatment of the educational institution as an industrial organization several points of view may be taken. That one which looks upon the student as the product of the factory or plant will be here dismissed without discussion as inherently false and as based upon very superficial analogies. In a second light the student may be regarded as the customer who buys the product instruction—possibly education—from the factory of which the workmen are the teachers. These theories, which the present writer has discussed at some length in another place,[1] will be passed over, in order that consideration may be given to a third viewpoint as follows.

The product of the college *considered as an industrial organization* is instruction; instruction in Greek, in chemistry, in mathematics, in history, or in any other subject which is there taught. The workmen of the educational factory fall into two classes: the instructors constitute the class of paid workmen; the students the class of unpaid workmen who may be looked upon, in a way, as apprentices. The product, instruction, can not be made except by the cooperation of the two classes of workmen. The finished product is education, or *an* education.

The analogy between the industrial plant and the educational institution is by no means as close as is asserted by those who advocate the application of the principles of business management to the college. It may be doubted if there be any instance of

[1] "The College as a Commercial Factory," *Educational Review*, December, 1913.

a factory which manufactures a product as intangible as the instruction of the educational plant, even though we neglect all the higher connotations of the word education and confine our attention to its lower and more utilitarian characteristics. Moreover, there probably exists no case of an industrial plant in which one class of labor pays a premium for the privilege of working for a limited period—three to six years—with the avowed intention of leaving the factory at the expiration of the term of service. There is no industrial plant which willingly and knowingly conducts its business at a loss; no business in which the product is never sold. Finally, it is impossible to conceive of an industrial plant in which, no matter how much of the product be disposed of, there still remains as much of the product in the factory as before.

II

For the sake of investigation, however, these discrepancies, these failures of analogy, may be overlooked, and we may proceed to the determination of costs on the hypothesis of a product, instruction; a class of paid workmen, the teachers; and a class of unpaid apprentices, the students, who pay a premium to the plant.

Adopting a usual classification of costs into (i) prime cost: workmen's wages and cost of raw material; (ii) works cost: prime cost *plus* the expense of shop production; (iii) total cost: works cost *plus* the expenses of administration and management; we may note that in the educational plant the second item is eliminated, and that there is practically no raw material.

Thus the items of cost fall into two classes: (1) Direct costs: salaries of the instructing staff. (2) Indirect costs: all costs except item 1.

But since the instructing staff is paid for both teaching and administration, item 1 must be subdivided into (*a*) Pay for instruction; *the only direct cost.* (*b*) Pay for administration; an indirect cost, and again subdivided into departmental and general administration costs.

Moreover, the various constituents of item 2 must be examined with care, in order that they may be properly allocated to different departments.

For purposes of illustration we shall assume a college of two departments, D_1 and D_2, with the following data. Department D_1 has 10 professors, salary \$3,000 each, serving 300 hours each per year; 10 associates, salary \$2,000 each, serving 400 hours each per year; 10 tutors, salary \$1,000 each, serving 500 hours each per year. Department D_2 has 5 professors, salary \$4,000 each, serving 250 hours each per year; 10 associates, salary \$2,000, serving 400 hours; 5 tutors, salary \$500, serving 500 hours each per year. The analysis of the data is given in the following table:[2]

TABLE I

Grade of Workman			Hours of General Administration	...urs of Departmental Adminis...tion	Co... of ...nst... ti... D...ars	Cost of General Administration Dollars	Cost of Departmental Administration, Dollars
Professor	10	1,000	1,000	1,000	10,000	10,000	10,000
		1,000	50	200	16,000	800	3,200
Associate	10	3,000	500	500	15,000	2,500	2,500
	10	3,000	500	500	15,000	2,500	2,500
Tutor......	10	4,000	500	500	8,000	1,000	1,000
	5	2,400	0	100	2,400	0	100
Totals..		8,000	2,000	2,000	33,000	16,800	13,500
D		6,400	550	800	33,400		5,800

The general administration costs—salaries of the president and other general administrative officers—amount to \$20,000 per year.

[2] This table of data is taken from the article in the *Educational Review* to which reference has already been made. The same article may be consulted for a tentative analysis of the several items of cost.

We shall assume that there are 200 students in department D_1 and 100 in department D_2. The two groups of students need not be mutually exclusive. A student may be doing work in both departments, or in one department only. The further assumption will be made that in department D_1 a student works 25 hours per week, in department D_2 20 hours per week, in classroom and laboratory. In addition, in department D_1 each student works 25 hours per week in preparation for class; in department D_2, 40 hours per week.[8] The year consists of 30 weeks, so that there are, in department

D_1, $50 \times 30 \times 200 = 300{,}000$ student hrs. per year.
D_2, $60 \times 30 \times 100 = 180{,}000$ student hrs. per year.

Finally, the tuition fee paid by each student will be assumed to be $150 per year. With these data we may proceed to the determination of *costs per workman per hour.*

The writer does not know any equitable basis for the distribution of general administration charges. They are certainly not necessarily allocable in proportion to the number of students in a department, nor in proportion to the number of student working hours, nor in proportion to the number of hours of teaching. A small department may, from the nature of its work, require more administrative attention than a large one. On the whole it seems best, in the absence of exact information, to allocate the general administration costs equally to the several departments.

The general administration costs of our hypothetical college are, therefore (see Table I.), $20,000 *plus* $16,800, or $36,800, of which $18,400 are chargeable to each department. From this and from Table I. we compute Table II., which summarizes all the data.

[8] No account is taken of home or preparation work done by the instructing staff.

TABLE II

General administration costs	$18,400	$18,400
Departmental administration costs	$13,500	$5,800
Wages of instruction	$33,000	$33,400
Working hours, teachers	8,000	6,400
Working hours, students	300,000	180,000
Total working hours	308,000	186,400
Total costs	$64,900	$57,600
Tuition fees	$30,000	$15,000
Net costs	$34,900	$42,600
Net cost per working hour	$.113	$.229

III

Examination of the assumed data will disclose the fact that the D_1D_2 college is a rather costly institution. Department D_1 pays $60,000 in salaries to 30 teachers, for 8,000 hours' instruction per year, for 200 students (there are 4,000 administration hours in addition) so that the average number of hours instruction per teacher per week is a little less than 9, and there are 6⅔ students to each instructor. In department D_2, 20 teachers receive $42,500 for 6,400 hours to 100 students, or about 10 hours per instructor per week, with 5 students to each instructor.

That the cost per working hour is so low is due to the neglect of most of the items of overhead burden, such as rent, power, heat, etc. But as our object is to test what conclusions may be logically drawn from costs computed on a correct theory of accountancy, and as we have no intention of attempting to apply our present results in practise, the omissions are unimportant.

It will be noted that the cost per working hour is much greater in department D_2 than in department D_1. If, however, we do not analyze the salaries paid to the instructing staff into their components, and if, instead of dividing the administration costs equally between the two departments, we allot them in proportion to the number of working hours, the workman-hour costs of the two departments approach much

nearer to equality,[4] giving a net cost per working hour, department D_1, of 13.8 cents; department D_2, 18.8 cents; a difference of 5 cents as compared with 12 cents under the more careful analysis.

In other words, by neglecting the analysis of the elements of cost, and by failure to allocate the various items where they should be incident; that is, by dealing with "general averages" instead of with specific charges, the cost per working hour becomes more nearly uniform. Consequently, exact information as to actual departmental costs is lacking or disguised; a result in precise agreement with managerial experience in general. To be of practical value cost per workman per hour, in the educational factory, must be based upon exact and detailed analysis.

IV

Further consideration of one or two points in the above discussion is desirable. Objection may be made to the inclusion of time spent by the student-workman in study at home, outside of the factory. Unless we limit the product (instruction) to the actual imparting of information in the class-room, a view altogether too narrow even on a strictly utilitarian basis, it must be granted that this home work is as essential to the product as is the factory labor, the work in school. The fact of the work being done outside of the factory does not affect the actual overhead expense or wages of the plant. It is conceivable that the student-workman might spend his entire working time in the factory without change of results. That he spends 50 per cent. or more of his working time outside of the factory amounts simply to his paying an additional premium for his apprentice privileges in the saving to the factory of expense, heat, light, attendance, etc. Theoretically each department should be credited with the amount of this salvage; practically the saving is *nil* as the expense, with the exception, perhaps, of light and attendance, is continuous in any case. The weakness of the plan adopted consists not in the inclusion of the student-workman's outside time, but in the exclusion of the outside time of the teacher-workman. If this latter were included there would be a further diminution of the cost per working hour in every department.

A real weakness of the plan under discussion lies in the fact that the outside student work is unsupervised to some extent, and may not be up to standard. This weakness, however, is inherent in the whole work of the educational plant; but not more so, by and large, than in the industrial plant. If it could be assumed that the inside work were 100 per cent. efficient and that all examination papers were perfect, then the percentage obtained on an examination would measure the quality and amount of a student's outside work. If, still with perfect examination papers, it could be assumed that all outside work were 100 per cent. efficient, the examination percentage would measure the efficiency of the combined student and instructor factory work, but would not differentiate between the two. If it could be assumed that all outside and inside work were 100 per cent. efficient, then the examination percentage would measure the efficiency of the work of preparing the examination paper. This might be called an equilateral triangle of untenable hypotheses.

[4] Total working hours 494,400. Working hours, D_1, 308,000, or 62.3 per cent.; D_2, 186,400, or 37.7 per cent. Whence, general administration costs, D_1, 62.3 per cent. of \$20,000, or \$12,460; D_2, 37.7 per cent. of \$20,000, or \$7,540. Therefore, net costs, D_1, are \$12,460 + \$60,000 — \$30,000 = \$42,460; D_2, \$7,540 + \$42,500 — \$15,000 = \$35,040. Whence the net cost per working hour is, D_1, \$42,460 ÷ 308,000 = .138; D_2, \$35,040 ÷ 186,400 = .188.

However, this weakness is by no means an insuperable objection to the present point of view of educational costs. It is sufficient, at least until the whole subject of cost accountancy shall have been put on a more scientific basis, to do in the educational what is done in the industrial plant: to compute costs on the basis of the workman-hour, even if the efficiency of the workman can not be accurately determined nor all the labor be adequately supervised.

V

When the management of an industrial plant investigates the question of costs it is for the purpose of determining the exact cost of each article produced, in order that the selling price may be fixed and a profit assured.

The educational plant disclaims all intention of making a profit, and has no customer, nor any product which is sold. When the management of an educational plant investigates the question of costs what is its purpose?

It has been said that it is well "to compare the cost of instruction per student hour"—the cost per workman-hour—in one department with the cost in another, and that "high cost will call for explanation and justification." The former assertion may be accepted as true without accepting the latter as a necessary consequence. It is quite as logical to say that low cost will call for explanation and justification. The analogy[5] between the industrial plant and the educational institution would seem to be an *ignis fatuus* destined to lead the investigator wandering into the morass of logical inconsequence.

The $\left\{\begin{array}{c}\text{educational}\\ \text{industrial}\end{array}\right\}$ plant makes $\left\{\begin{array}{c}\text{an intangible}\\ \text{a tangible}\end{array}\right\}$ product $\left\{\begin{array}{c}\text{not to be sold}\\ \text{to be sold}\end{array}\right\}$ at a profit. In the industrial plant, the lower the cost the greater the profit. Therefore, the $\left\{\begin{array}{c}\text{educational}\\ \text{industrial}\end{array}\right\}$ plant should produce at the lowest cost possible. This would seem to be the argument. It may be allowed to stand on its own merits.

In the second place, there can be no valid comparison of the costs of widely dissimilar products. If an industrial plant makes tin cups at a cost of 25 cents and silver cups at a cost of 25 dollars per working hour, surely the high cost of the silver cup, *as compared with the tin cup*, does not call for explanation and justification. If in a factory, in a given number of hours, say one hundred, there are made 1,000 silver cups by 100 men at a cost of 25 dollars each, 100 silver flagons by 50 men at a cost of 100 dollars each, and a single silver ewer by one man at a cost of 500 dollars, the costs per workman hour are $2.50, $2 and $5 respectively. Now it may be perfectly true, as has been said, that "the principle of efficiency"—or the principle of economic common sense, for that matter—"demands that the expenditure be commensurate with the results produced." But whether the results be commensurate or not can not be determined by comparing expenditures only. Certainly it can not be said that expenditure and results are not commensurate in the case of the silver ewer *because* the cost per ewer working hour is double the cost per cup working hour. The results may be, for the cups a ten per cent. profit, or $2,500; for the ewer a 500 per cent. profit, or $2,500. Even if the profit on the ewer were only ten per cent., or $50, still the ewer might be a Cellinian masterpiece, which counts as "results" even in business. Mechanical engi-

[5] "Analogy: a resemblance of relations; an agreement or likeness between things in some circumstances or effects, when the things are otherwise entirely different."

neering may be costing 46 cents per working hour, English 18.2 cents. Either may be costing too much, or each too little. As for the results, the unfinished products, engineering instruction or English instruction, or the finished product, education, they still await measurement.

VI

Doubtless it would be well for the college to know exactly how it is spending, how it is losing, its money. What must be guarded against especially is the misuse of statements of costs, as well as inaccurate statements of costs derived from insufficient data and unscientific investigation. A determination of the cost per student hour, or per working hour, which does not separate salaries of the instructing staff into wages, general administration and departmental administration charges; which does not properly allocate to various departments costs of rent, power and other items; which makes no attempt "to apportion the overhead expense exactly, as would be done in a manufacturing business"—such a determination may, perhaps, be valuable and suggestive if applied to a hypothetical college, but is misleading and dangerous if applied to an actual institution for the purpose of deducing practical consequences and suggesting practical reforms.

There is no consensus of opinion as to what education is—except, perhaps, the widespread view that it is a failure—and no general agreement as to what it should be. It is, perhaps, unfortunate that so much attention is being given to the determination of the costs of this unknown quantity; unfortunate that, obsessed by the slight analogy between industrial and educational organizations, so many investigators and writers fail utterly to see the innumerable and insuperable differences between education and business. It is true that as yet but little harm has been done, but there are indications that if this tendency be not checked serious evil may follow.

The executive and administrative branches of the educational business are coming to be looked upon as its trunk and its roots. The college is coming to be looked upon as an establishment in which education is administered, not as a seat of learning, where knowledge is taught, scholarship fostered and wisdom diligently sought. The teacher is no longer looked upon as an essential part of education; he is no longer an individual, teaching in freedom and earnestness, but is simply one of a numerous class of underpaid workmen whose betterment is impossible and whose usefulness is doubtful. In investigating the costs of the educational institution it will be well to count these costs of education treated as a business, and to take heed lest academic liberty be sacrificed to executive demands; lest truth be sacrificed to expediency.

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FLOOD PREVENTION AND ITS RELATION TO THE NATION'S FOOD SUPPLY

The problem of preventing the enormous losses from floods is one of the greatest before the American people. It is second only to that of increasing the nation's food supply and, thereby decreasing the cost of living. That the two problems are closely related will be seen from the following facts and figures taken from statements made by experts who have not been contradicted.

These few facts, which have been culled from a mass of overwhelming evidence should convince every reasonable person—

First: That the federal government's present policy of river regulation is wrong.

Second: That a better policy is possible and is now under consideration by Congress.

Third: The necessity for the immediate adoption of the new policy.

The present policy of building levees only is radically wrong because it ignores the necessity of preventing flood conditions, and is

confined to efforts to protect the banks of the river from overflow. In this the levees have failed. For although the government appropriates millions of dollars for such work, we nevertheless continue to have floods, causing the loss of many lives and the destruction of property valued at more than 100 millions of dollars a year averaged over a ten-year period. This levee system has also been tried on the Hoang Ho in China for thousands of years, and has failed there.

In this country the damage done by floods has been appalling. You remember well what happened at Dayton, Ohio, this year. You remember the photographs showing the terrible conditions in that city. The same conditions have caused heavy damage in *other years*, at other places. Pittsburgh, Cincinnati, Memphis, New Orleans, have all suffered. These cities are all in the Ohio and Mississippi River basin. Other rivers have overflowed and caused great damage without attracting so much attention.

The government by allowing flood waters to accumulate and rush towards the sea during the season of freshets and melting snow permits the food-producing power of the country to be reduced. This reduction results from three different processes.

First: The upland is robbed of moisture that is greatly needed by maturing crops.

Second: An enormous amount of valuable top-soil is lost by erosion.

Third: The lowlands are drowned. While the lowlands are much less in area than the uplands, their possible producing power is far greater per acre. In fact, they are the richest lands in the world. The loss from erosion is beyond computation.

Under the present policy of building levees only it is admitted that the banks of the Mississippi between Cairo and Donaldsonville *cave* in each year to the extent of 9½ acres a mile for a distance of nearly 1,000 miles. Each year, therefore, nearly 10,000 acres of the best land in the world is deliberately surrendered to the floods. Engineers when building the levees place them back as far from the edge of the river as they think will be necessary to last 15 or 20 years. Is that a business-like proposition? It is estimated that *1,250,000,000* tons of silt are deposited annually in the Mississippi River. Of this amount 600 million tons flow out through the mouth of the river and *650 million* tons remain to fill up the channel. This 650 million tons is 2½ times the amount excavated in digging the Panama Canal.

It should be borne in mind that this enormous damage by soil erosion applies not only to the farms that lie adjacent to our great rivers, but that a very larger percentage of the six million farms in the United States suffer great losses from soil erosion, and a consequent decrease in production. It should also be noted that under the present methods the navigation of the rivers in the upper reaches is almost impossible during the seasons of drouth. In fact, there are times when there is scarcely enough water for sanitary drainage. The *storage reservoir system* would assure navigation throughout the dry season.

The facts and figures above quoted show how important it is to conserve all precipitation. That this can be done has been conclusively demonstrated in different sections of the country. Col. Freeman Thorpe, of the Minnesota Horticulture Society, who owns a large experimental farm near the headwaters of the Mississippi River, has allowed no water to run off his farm for 17 years. His farm consists of cultivated land, pasture and forest. His methods are extremely simple and inexpensive, consisting chiefly of contouring and embankment work, the effect of which has been to *double the annual growth* of *trees* in his forest, more than *double the capacity of the grazing land,* and add largely to the productivity of the cultivated land.

Col. Thorpe declares that there are over *300 million acres of land* now *idle* on the great central plateau of the United States for the want of sufficient rainfall. This, he says, would be the best soil for scientific farming, if we compelled the *filtration into* the *soil of all* the *limited* precipitation. In other words, if the *actual* precipitation were conserved all this land would be available. Professor Waite, of the Department of Agriculture, owns a farm between Washington and Baltimore,

where he has worked along the same lines with results similar to those secured by Colonel Thorpe in Minnesota.

Government officials report that the cultivable land of the United States is capable of producing sufficient food to supply a billion people. If that is true why does the country actually suffer because of the scarcity and consequent high price of food. The main reason is a lack of water due to waste.

I shall now outline the *new* policy for which there is an insistent demand from all parts of the country. This new policy is based upon the old and wise adage that an *ounce* of prevention is worth more than a *pound* of cure. The policy to which I refer is proposed by U. S. Senator Francis H. Newlands and is now before Congress as the Newlands Bill. Briefly stated the main object of this bill is to *prevent* the swelling of the rivers and the waste of water during the period of freshets, by the construction of reservoirs along the source streams and also diversion canals for irrigating purposes and for raising the underground water level.

The details of the plan are to be in accordance with agreements between the federal and state governments and such corporations and individuals as may hold vested rights in the matter. The watershed of every river and stream will be protected. And it is proposed that the work shall be done by the engineers who have charge of the work at Panama.

That the nation's supply of water is of vital importance will be seen from the following figures. The amount of water required by the average soil for full productivity is 60 inches each year. How far short of this required amount the actual precipitation of rain and melted snow is, will be seen from the reports of the Weather Bureau.

Weather Bureau experts divide the United States into three districts. That portion lying east of the states of Kansas and Nebraska is called the eastern or humid section. In this section the annual precipitation is about 48 inches, or four fifths of the amount required. It is estimated that 30 per cent. of this 48-inch precipitation is allowed to go to waste. The soil, therefore, receives benefit from only a trifle more than half the amount needed.

The next section comprises the states of North and South Dakota, Nebraska, Kansas, Oklahoma and Texas and is called the median or sub-humid section. In this all-important section the total average precipitation is only 30 inches. This amount is supplemented, we are told, by natural sub-irrigation from the mountainous country farther west. This sub-irrigation does not average, however, more than 5 inches. It will therefore be seen at a glance that every drop of water falling in that section should be utilized if possible.

The third section is that part of the country lying west of the median states and is called the westward or semi-arid section. The rainfall here averages only about 12 inches, or one fifth of required amount. Comment concerning waste of water in this section is superfluous.

Let me now quote from another official report which clearly indicates the importance of water. This report issued by the government, after referring to the fact that growing plants require nearly 1,000 times their weight of water says:

> A pound of bread is the equivalent of two tons of water used by the growing grain; and a pound of beef the equivalent of 15 to 30 tons of water consumed by the animal, both directly and indirectly through feed. So that the adult person who eats 200 pounds each of bread and meat in the course of a year consumes something like one ton of water for drink, 400 tons for bread and 4,000 tons for meat, making 4,401 tons of water in all.

The question of conserving the water supply of the country is therefore second to none and the federal government could do an immense amount of good by publishing and conspicuously displaying in every post office, railroad station and schoolhouse in the United States, charts and photographs showing and explaining the method of contouring and embankment employed by Colonel Thorpe and Professor Waite, and warning farmers, planters and other landowners to conserve all precipitation.

The secretary of the National Reclamation

Association, Mr. Walter Parker, of New Orleans, declares that there are ten million acres of land in the upper Missouri River basin that could be sufficiently irrigated to yield a crop of hay worth more than one hundred million dollars each year. This land would require no seeding, only water. A kind Providence has furnished the soil and placed the seed in the soil and sends sufficient rain and snow to germinate the seed and support the growing plants. It only remains for man to utilize the precipitation, and receive the benefit.

You are urged to consider the above figures in connection with the present high cost of food. This high cost of food is undoubtedly due to the fact that millions of acres of land are producing nothing, while hundreds of thousands of farms in all sections of the country are producing only a fraction of the possible productivity, owing to the lack of water. It should also be noted that the construction of dams and reservoirs would also result in a large development of hydro-electric power. This increase of electric power should decrease the cost of production and should therefore be a contributing factor in decreasing the cost of living. The Newlands Bill recognizes the absolute necessity of conserving the food supply of the nation, which food supply is in such imminent danger from waste of water and from waste of soil by erosion. It would therefore seem that the bill is one that every person who is interested in the cost of living should urge their representatives in Congress to support.

We are told that the chief opposition to the Newlands Bill comes from the railroads. If this is true, the railroads have adopted a very unwise and short-sighted attitude. All fair-minded people realize and concede that the railroads are by far the most important industry of the country. Personally, I believe that the federal government should do all that it properly can to promote the safety, solvency and prosperity of the railroads. But the railroads would not suffer by the adoption of the Newlands plan, for the reason that they would gain through the increased productivity of the soil far more than they would lose through competition with water transportation.

Among those who recognize the importance of a new policy that will prevent this enormous waste of water and soil are President Wilson, ex-Presidents Taft and Roosevelt. The Congress of Governors which met at the White House in 1908 also strongly endorsed the new policy, which is splendidly stated by a Philadelphia newspaper, from which I quote as follows:

> We must prevent floods. We can make use of the natural reservoirs which nature has provided for the absorption of rains, and we can create artificial reservoirs for the storage of flood waters, as we are now doing on the Panama Canal. The natural reservoirs are the forests and the agricultural lands which absorb the rainfall and the melting snows. Our aim should be everywhere to increase the porosity and absorbent properties of the soil and thus prevent run-offs, which swell our streams into great floods, which now aggregate a damage upon property of the stupendous sum of nearly 200 millions a year in the United States.

We have land enough to produce food sufficient to supply a billion people. But we can supply nothing without water. Wastefulness is our national sin. Wastefulness of men, of time, of money, and of our great national resources, but I believe the figures I have quoted prove conclusively that we can not afford to continue to waste water. In conclusion, attention is called to an old saying to the effect that if each before his own door would sweep, the village would be clean. Let me paraphrase this by saying that if each and every farmer, planter and landowner would prevent the wasteful run off of water from his land, there would be no more floods or danger from floods, and the land would be so benefited that its value would be enhanced to an amount many times greater than the cost of operation, and the entire nation would benefit to a degree beyond computation.

JUDSON G. WALL,
Chairman of the Committee on Soil Erosion of the Social and Economic Section of the American Association for the Advancement of Science

Note.—Since the above was written the United

States Department of Agriculture has decided to make a special study of the methods adopted by Colonel Thorpe.

A NOTABLE BOTANICAL CAREER

I have before me the "Report of the Botanist" to the Regents of the University of the State of New York, bearing date of January 1, 1868, covering less than two pages, and signed by Charles H. Peck. There is internal evidence that his services began July 1, 1867, the writer reporting what he had accomplished in the half year since that date. A year later the "Report of the Botanist" covered about 80 pages and included a short general statement followed by (*A*) List of Species of Which Specimens Have Been Mounted; (*B*) Plants Collected; (*C*) List of Species of Which Seeds Have Been Collected; (*D*) Specimens Obtained by Contribution and Exchange; (*E*) Edible Fungi; (*F*) Species Growing Spontaneously in the State and Not Before Reported. This general sequence of topics has been characteristic of the long line of annual reports that followed these made forty-six years ago.

The latest report in this series was issued September 1, 1913, and was entitled the "Report of the State Botanist for 1912." Like its predecessors in recent years it contains an introductory general statement followed by (*A*) Plants Added to the Herbarium; (*B*) Contributors and Their Contributions; (*C*) Species not Before Reported; (*D*) Remarks and Observations; (*E*) New Species of Extralimital Fungi; (*F*) Edible Fungi; (*G*) Poisonous Fungi; (*H*) *Crataegus* in New York. Four plates (of fungi) and an index complete the pamphlet of one hundred and thirty-seven octavo pages.

As one looks back over this long series of reports, all from the hand of one man, Dr. Peck, he is powerfully impressed with the thought of what such a life of scientific activity has meant for the development of one branch of knowledge in North America. I was a young teacher just entering upon the work of enumerating the plants of Iowa when these reports began to appear, and remember with gratitude the help they gave me, and the still more helpful correspondence which beginning then has continued to the present. And this is not an individual experience, as may be seen by running over the lists of those who sent their difficult specimens to him for determination, and reported by him under the heading of "Contributors and their Contributions." The younger botanists of to-day have grown up with an abundance of books on the fungi, and with competent mycologists in so many of the colleges and universities that it has been as easy for them to learn the names of the fungi as of the flowering plants. They have not found it necessary to send their specimens to a far-away specialist for determination. So we should not expect them to have the same feeling with regard to a career like Dr. Peck's, as those of us have whose work began half a century ago. Yet for their sakes we may well pause here to enumerate some of the principal things in this man's life.

Charles Horton Peck was born March 30, 1833, at Sand Lake, N. Y. He graduated from Union College in 1859, with the degree of bachelor of arts, and later he was given the degrees of A.M. and D.Sc. by the same institution. For several years (1859 to 1867) he followed the teacher's profession, first in the Sand Lake Collegiate Institute, and later the Albany Classical Institute. Then he began his real life work as botanist for the New York State Museum, at Albany, and this has continued until the present time.

And now while we write the saddening word comes of such increasing physical infirmities due to advancing years as may well require him to rest from his long years of labor. There are to-day many botanists all over the country who will read this latest report with old-time interest, added to a personal regard for the veteran who has long occupied so prominent a place in the botanical field. It is given to few men to prepare such a report as this latest one at the age of four score years. It is the fortune of few to have erected so notable a monument as he has in the series everywhere known as "Peck's Reports."

Charles E. Bessey
The University of Nebraska

M. ALBERT LACROIX

At the meeting of the Paris Academy of Sciences, held June 7, M. Albert Lacroix was elected perpetual secretary for the class of physical and natural sciences, by 37 votes against 22 cast for M. Ternier, his only opponent. This merited honor will afford the greatest satisfaction to the many friends and admirers of Professor Lacroix. Still comparatively young for a scientific man (he was born in 1863) M. Lacroix began his special career in the petrographic laboratory of the Collège de France, and soon published, in collaboration with M. Michel-Levy, a valuable study entitled: "Les mineraux des roches." His great work "La Mineralogie de la France et des ses Colonies," has just been completed, and ensures to the writer a foremost place among the mineralogists of the world. Special studies on the granites of the Pyrenees and their contact phenomena, as well as the invaluable records of his investigations when sent in 1902 by the French government as director of the mission to Martinique after the fearful disaster from the eruption of Mont Pelee, constitute additional titles to high consideration. In the course of the Martinique expedition, M. Lacroix more than once exposed his life in the interests of science, notably on one occasion when, while in the flames of the death-dealing mountain, an emission of poisonous vapor passed within a hundred feet of where he was standing, destroying everything in its passage. Fearlessly utilizing this terrifying spectacle in the interests of science, the undaunted explorer photographed the phenomena, thus preserving a unique record of the appearance. He has explained that this "burning cloud" was the result of a formidable explosion, that it might, indeed, be regarded as a sort of projectile hurled out by the mountain, half-solid, half-gaseous, of very high temperature, and which in contradistinction to most volcanic emissions of vapor, although thrown up vertically into the air, descends upon the slopes of the volcano, under the duplex influence of the initial explosion and of the force of gravity, and sweeps everything before it. Its speed often exceeds fifty meters a second, and its convolutions are so dense and closely bound together and its outlines so clearly defined that only a few meters separate the zone of total destruction from that in which nothing is harmed.

The election of M. Lacroix as a member of the Academy of Sciences in 1904 was a fitting recognition of these and other labors in his special field. In 1906 he was entrusted with another mission for the study of volcanic phenomena, Vesuvius being this time the chosen locality. At present M. Lacroix has the professorship of mineralogy in the Museum d'Histoire Naturelle, and his laboratory in that institution is a favorable resort for all French explorers who are investigating the mineral riches of France or her colonies. The unfailing courtesy and amiability of the distinguished mineralogist contribute not a little to the advantages derived from a visit to the scene of his activity.

K.

THE LASSEN ERUPTION

A report forwarded to the U. S. Geological Survey, Washington, by geologist J. S. Diller reads in part as follows:

Mount Rainier and Mount Shasta, the beautiful cones so much in evidence to the traveler on the Pacific Coast north of San Francisco, are now finding an up-to-date rival in Lassen Peak, which is plainly in view from the railroad for many miles in the Sacramento Valley between Redding and Red Bluff. Lassen Peak is the southern end of the Cascade Range, and it stands between the Sierra Nevada on the southeast and the Klamath Mountains on the northwest. Its lavas erupted in past ages reach the Sacramento Valley on the one side and on the other form a part of the vast volcanic field, one of the greatest in the world that stretches far across California, Oregon, Washington and Idaho to the Yellowstone National Park.

Of all portions of the Cascade Range Lassen Peak still retains the largest remnant of its once vigorous volcanic energy. Morgan and Suppan Hot Springs and Bumpass Hell on

the south as well as Hot Springs Valley and the boiling mud-lake Tartarus on the southeast have long attracted the attention not only of Californians but to some extent of the tourists, to whom the region is growing more accessible every year. If to these already established attractions be added a frequent occurrence of the recent volcanic plays of Lassen Peak the region will take high rank among nature's wonderlands.

But what is the nature of this new activity of Lassen? Is it really volcanic? Will it soon dwindle and become wholly quiescent or on the other hand is it the precursor of a more profound eruption like that of Krakatoa? The excellent photographs that have been taken of the outburst, especially those by G. F. Milford and the series by B. F. Loomis, of Viola, taken from a point six miles northwest of Lassen Peak, leave little doubt in the mind of any one familiar with volcanic phenomena that the outburst is essentially volcanic. These photographs are strikingly similar to those taken by Johnston-Lavis showing the progress of an eruption in the Lipari Islands, whose volcanic character is well known.

The eruptions of Lassen Peak began May 30 at 5:30 P.M., with an outburst of steam which, according to Forest Supervisor W. J. Rushing, continued about 10 minutes. It formed a crater in the snow-covered summit of Lassen about 25 by 40 feet in extent and covered the encircling snow for a distance of 300 feet with a mantle of dark wet dust. Harvey Abbey, a forest ranger, visited the scene and reported the facts.

On the following day at 8 A.M., another eruption occurred and on June 8, a week later, the third and much larger outbreak took place. It lasted 30 minutes and the rolling column of dense black smoke rose to the height of 2,500 feet. Stones were hurled from the crater and the forest service outlook house, a quarter of a mile away on the tip-top of Lassen Peak, was broken by some of them. Blocks and smaller fragments accumulated about the crater to a depth of several feet. The dust and sulphurous gases carried southward by the wind were observed at Mineral, the forestry station, and the dust was noted 5 miles beyond. Forest rangers who were in the neighborhood of the summit during the eruption heard the rushing steam and the falling rocks but report no rumbling or subterranean noises, earth shocks, electrical phenomena or great heat beyond that of steam. The dust was practically cold when it fell. Considerable volumes of water were ejected probably wholly in the form of steam. The water condensing from this steam washed a gully in the snow to the adjacent lakelet which occupies what prior to this latest eruption had long been regarded as the youngest crater of the Lassen volcano. The new crater is not quite over the throat of the old but is a few hundred feet to the northwestward.

In all there have been eleven eruptions up to the date of this report—June 21. The most violent was at 9 A.M., June 14, when several over-venturesome persons were injured by falling or rolling stones. The eruption was visible from the Sacramento Valley nearly 40 miles away and created profound interest. The subsequent eruption on Friday, June 19, was of relatively small energy. Mr. Rushing reports that eruptions are generally, if not always, preceded by a complete cessation of escaping steam.

With successive eruptions the new crater is enlarging. June 20, when Mr. B. F. Loomis and I visited it, it was 400 feet long and 100 feet wide with a depth of not over 100 feet. It appears to follow a fissure running a little north of east and south of west. The escaping steam from the southwest end of the fissure is visible in the excellent photograph obtained by Mr. Loomis.

The other hot holes about Lassen Peak as far as I can learn have not increased their activity unless it is Bumpass Hell which is always fuming; but nothing like an eruption has been reported.

No definite molten products have been found in connection with the recent eruptions of Lassen Peak. The ejected dust as far as can be judged from an examination with a small pocket lens is disintegrated or pulverized da-

cite, perhaps in part decomposed. The quartz and apparently also the glassy feldspar are bright but the hornblende, augite and mica are of course not so abundant in the dacite and are less evident. An examination with a petrographic microscope confirms the conclusion that the dust is the product of the pulverizing action of the explosive gases on the rocks through which they are escaping, and not the result of the explosive expansion of gases in a liquid lava.

That heat has recently risen in the core of Lassen Peak is evident from the fact that whereas it was once cold now it is hot and steaming. When E. E. Hayden and I were on the mountain in July, 1883, and slid down the 2,000-foot snow bank into Hat Creek on our way to Yellow Butte there was no sign of heat in the summit of Lassen Peak. The rocky summit of the peak, struck by many thunderbolts during storms and superficially fused here and there by the lightning to fulgerite, is still as it was then and the little lake is there as in 1883; but the heat and the crater are new. Mr. Rushing tells me that these new features appeared with the first eruption. But the fact that the other hot places about the mountain are not yet perceptibly hotter indicates that the rise of temperature is local and does not at least as yet affect the mountain mass. Time alone can tell what Lassen is going to do. The volcano may subside to its former quiescence. But we must not forget that it was only the top of the old Vesuvius that was blown off to make Monte Somma and the Vesuvius of to-day. Krakatoa blew up from the very base with tremendous effect. There seems no good reason at present to fear a Krakatoan outbreak at Lassen Peak, but the part of wisdom dictates a close watch.

Eruptions, as a rule, break out suddenly. Sight-seers will generally find the viewpoint from which Loomis's photographs were taken close enough if the mountain is active, but if all is quiet and the seeker after knowledge must see the crater for himself he should be sure to ascend on the windward side, and approach with caution.

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM OSLER, regius professor of medicine in the University of Oxford, has been elected a foreign associate of the French Academy of Medicine.

MCMASTER UNIVERSITY, Toronto, has conferred the degree of doctor of laws on Mr. David Hooper, late economic botanist of the Botanical Survey of India.

THE honorary degree of doctor in engineering has been conferred by the Royal School of Mines, Freiberg, Saxony, on Edward Dyer Peters, Gordon McKay professor of metallurgy at Harvard University. The degree was conferred upon Professor Peters in recognition of his academic and practical services and writings on the metallurgy of copper.

SIR ST. CLAIR THOMSON has been elected an honorary fellow of the American Laryngological Association. There were only four living honorary fellows of the association—Professors Chiari, Massei, Moure and Sir Felix Semon.

THE Aeronautical Society of Great Britain has awarded its gold medal to Professor G. H. Bryan, of the University College of North Wales, for his work on aviation. The previous recipients of the gold medal of the society, which is the highest award of British scientific aeronautics, are Wilbur and Orville Wright (1909), and Octave Chanute (1910).

A CIVIL list pension of $600 has been granted Mrs. Annie Wallace, widow of Alfred Russel Wallace, in consideration of his eminent services to science and her inadequate means of support.

FROM the long list of honors conferred on King George's birthday on June 22, *Nature* selects the following as having done work for science: Sir Leonard Lyell, Bart., a nephew of Sir Charles Lyell, and formerly a professor of natural science in the University College of Wales, has been made a peer. Colonel S. G. Burrard, F.R.S., surveyor-general in India, has been appointed a K.C.S.I., and Mr. R. A. S. Redmayne, C.B., chief inspector of mines, has been promoted to the rank of K.C.B. The new knights include: Dr. J. G. Frazer, author

of "The Golden Bough"; Dr. W. P. Herringham, vice-chancellor of London University, physician to St. Bartholomew's Hospital; Dr. W. H. St. John Hope, archeologist; Dr. W. Milligan, known by his investigation into the connection of human and animal anthrax; Lieut.-Colonel Leonard Rogers, Indian Medical Service, professor of pathology, Medical College, and bacteriologist to the government, Calcutta; Dr. T. Kirke Rose, chemist and assayer to the Royal Mint; Dr. S. J. Sharkey, lecturer on medicine at St. Thomas's Hospital, and Mr. J. F. C. Snell, president-elect of the Institute of Electrical Engineers. The honor of knight bachelor has been conferred upon Dr. Douglas Mawson, the Antarctic explorer, and Professor T. P. Anderson Stuart, dean of the faculty of medicine at Sydney University. Mr. R. Meredith, director of telegraphs, India; Mr. A. Howard, imperial economic botanist at Pusa, Bengal; Major E. D. W. Greig, assistant director, Central Research Institute, Kasauli; Dr. T. Summers, late Bombay Public Works Department, and Mr. R. H. Tickell, chief engineer, Central Provinces, have received the honor of C.I.E. Dr. H. R. D. Spitta, bacteriologist to his Majesty's household, has been appointed M.V.O. (fourth class).

Dr. Erwin Baur, director of the Institut für Vererbungsforschung of the Königlichen Landwirtschaftlichen Hochschule in Berlin, has been appointed Carl Schurz memorial professor in the University of Wisconsin for the first semester of 1914–15. Dr. Baur will take up his residence in the university about the first of November, and will remain until the end of the semester.

Professor F. E. Austin, during the past six years head of the department of electrical engineering at Norwich University, has resigned to engage in engineering education extension work and the publication of several engineering books. During the present summer Professor Austin has charge of special classes in electrical engineering at the Thayer School of Engineering, Dartmouth College.

The disastrous fire at Salem, Mass., spared the Peabody Museum and the Essex Institute. The house of Dr. E. S. Morse, with its valuable papers, drawings, books and collections, also narrowly escaped.

Sir David Gill left the Royal Astronomical Society of London the sum of £250 to be employed by the council of the society in aid of astronomical research in grateful remembrance of the like sum paid out of the funds of the society in aid of his expedition to Ascension in 1876. He expressed the wish that the sum be devoted to some expenditure of a similar character, or to complete some work, such as the computation of new tables of the satellites of Jupiter.

Sir James Key Caird, of Dundee, has given $120,000 toward the expenses of the Shackleton Antarctic expedition.

M. Ole Olsen has offered to place at the disposal of M. Knud Rasmussen, the Arctic explorer, sufficient funds (about $75,000) for the fitting out of a North Pole expedition. The expedition, which will take provisions for two years, will be provided with all modern appliances and will be accompanied by staffs of scientists. The base will be at Cape York, in Greenland.

The Astronomical and Astrophysical Society will meet at Northwestern University, Evanston, Illinois, August 25–28.

An International Congress of School Hygiene will be held at Brussels in 1915, under the presidency of M. Corman, director-general of the ministry of public instruction, and Dr. Demoor, rector of the University of Brussels.

According to a resolution of the international executive committee chosen at the last congress in Paris, the Fifth International Congress of Genetics will be held in Berlin in 1916. The committee consists of representatives of the various German agricultural and horticultural societies. Wirkl. Geheim. Dr. Thiel is chairman. The congress will convene during the first week in September, 1916. The address of the subcommittee in charge of preliminary arrangements, Professors von Rümker

and Baur, is Berlin N. 4, Invalidenstr. 42, Kgl. Landwirtsch. Hochschule.

AT a meeting of the American College of Surgeons held in Philadelphia under the presidency of Dr. J. M. T. Finney, of Baltimore, on June 22, attended by eight hundred members, over $100,000 was subscribed toward an endowment fund for the establishment in Washington, D. C., of a permanent home for the institution. One thousand one hundred fellowships were conferred, bringing the total membership up to over three thousand.

THE advisory committee of the Tropical Diseases Research Fund (British Colonial Office) has granted £100 as a stipend for a helminthologist to conduct research work in the Quick Laboratory, University of Cambridge, and has contributed £300 with which to send Mr. E. Hindle, B.A., on an expedition to East Africa. Sir Dorabji J. Tata has contributed £250, and Mr. P. A. Molteno and Mrs. Molteno £400, towards the research work at the Quick Laboratory.

A COOPERATIVE fire agreement which has been entered into between the U. S. Department of Agriculture and the state of Michigan provides for an expenditure by the government of not to exceed $5,000 a year toward meeting the expenses of forest fire protection in Michigan. This form of cooperation between the government and the state is made possible by a law which congress passed in 1911, and which has already been taken advantage of by the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, West Virginia, Kentucky, Wisconsin, Minnesota, South Dakota, Montana, Idaho, Washington and Oregon. The law, besides providing for the purchase by the government of lands on the headwaters of navigable rivers for the purpose of creating national forests to protect these rivers, appropriated $200,000 which the secretary of agriculture might expend to protect similar lands in state or private ownership from fire, in cooperation with the states. It was provided in the law that the federal expenditures in any state should not exceed the amount spent by the state itself in the cooperative work. Provision for continuance of the work in the fiscal year which began July 1 has been made by an appropriation of $100,000 for the year. The original appropriation of $200,000 was available until expended, and with a supplementary $75,000 has carried the work to the present time.

THE most notable progress yet recorded in the chemical treatment of timber to prevent decay was made in 1913, according to a report recently issued by the American Wood Preservers' Association in cooperation with the forest service of the department of agriculture. The report states that 93 wood-preserving plants in 1913 consumed over 108 million gallons of creosote oil, 26 million pounds of dry zinc chloride, and nearly 4 million gallons of other liquid preservatives. With these the plants treated over 153 million cubic feet of timber, or about 23 per cent. more than in 1912. The output from additional plants unrecorded would increase the totals given. Impregnation of wood with oils and chemicals to increase its resistance to decay and insect attack, the report goes on to say, is an industry which has become important in the United States only in recent years. In Great Britain and most of the European countries practically every wooden cross-tie and telephone or telegraph pole receives preservative treatment. In the United States less than 30 per cent. of the 135 million cross-ties annually consumed are treated, and the proper treatment of an annual consumption of 4 million poles may be said to have scarcely commenced. Real progress in the United States dates from 1832, when the Kyanizing process, using bichlorides of mercury, was developed. In 1837 two other processes were introduced, the Burnett process using zinc chloride, and the Bethel process using coal tar creosote. These last processes are very largely in use to-day. The idea of timber preservation at first made very slow growth in this country, on account of the large supply of cheap and durable timbers and the general disregard shown toward economy in the use of natural resources. In 1885 there were only three pressure plants

in the United States; and in 1895 only 15. Since then, however, the industry has grown rapidly; in 1913 there were 117 plants.

Professor Charles E. Porter, occupying the chair of general zoology and applied entomology and director of the recently established museum and laboratory of economic zoology at the National Agricultural Institute of Santiago, Chili, has undertaken the publication of a new scientific journal under the title "Anales de Zoologia Aplicada." This journal is to be especially devoted to original studies on species beneficial to and parasitic on man, domesticated animals and cultivated plants in America. The "Revista Chilena de Historia Natural," edited by Professor Porter, is being continued, but only for systematic papers. The "Anales de Zoologia Aplicada" will be published quarterly, illustrated with text figures and when necessary with plain or colored plates. It will accept original contributions on American parasites.

"Art and Archeology" is the title of a new non-technical illustrated magazine published by the Archeological Institute of America, the first number of which bears the date of July, 1914. During the present year four numbers will be issued, but commencing with 1915 the magazine will appear monthly. Its fifty pages are devoted to articles covering a considerable range, and to minor notes and brief book reviews. The editorial staff consists of: General Editor, David Moore Robinson, Johns Hopkins University; Advisory Editor, Allan Marquand, Princeton University; Art Editor, William H. Holmes, Smithsonian Institution; Associate Editor, Ralph Van Deman Magoffin, Johns Hopkins University; Contributing Editors, H. Rushton Fairclough, Stanford University, Charles H. Weller, University of Iowa, Albert T. Clay, Yale University, Frederick W. Hodge, Smithsonian Institution, Charles T. Currelly, Royal Ontario Museum, George H. Edgell, Harvard University; Managing Editor, Mitchell Carroll, General Secretary, Archeological Institute of America, The Octagon, Washington, D. C.

A group representing a number of deep-sea luminous fishes has been completed in the American Museum of Natural History and opened to the public. It represents ten species of fishes found in the depths of the sea, half a mile or more from the surface. Some of the fishes are provided with rows of luminous organs or with headlights, while others have a light at the end of a tentacle with which to attract their prey. The group is illuminated by electricity in such a way that the fishes may be viewed first as synoptic specimens in a case and secondly, as if they were living fishes swimming in the darkness of the deep sea, lighted by their own luminous or phosphorescent organs.

A little more than 33,000 acres in the White Mountains have been approved for purchase by the government at a meeting of the national forest reservation commission. These areas are in two separate tracts, both in Grafton county, New Hampshire, the larger containing 31,100 acres on the watershed of the Pemigewasset River, a tributary to the Merrimac. The tract comes within a mile of North Woodstock on the Boston and Maine railroad, and several good roads lead through it. The land is between 700 and 4,300 feet in elevation, and in the lower valleys are a number of abandoned farms now grown up to trees. Most of the conifers have been cut to make paper pulp, but there are good stands of beech, birch and maple of considerable value. With fire kept out there is said to be excellent promise of a new stand of spruce. The price agreed upon by the government is $4.62 an acre including both land and timber. The smaller purchase consists of several areas lying on the watersheds of Little River and Gale River, both tributaries of the Connecticut. These lands cover 2,000 acres and are contiguous to lands already approved for purchase; hence they go far toward giving the government a solid body of land in this locality. The price for the 2,000 acres, land and timber, is $4.00 an acre. The tract is in the locality of the noted Franconia Range and is readily accessible from two railroad stations, Bethlehem and Twin Mountain. The forest has been cut over and consists chiefly of the northern hardwoods, though some spruce remains from the

original stand. At the same time that these White Mountain areas were approved, the commission also approved the purchase of the Pisgah Forest in North Carolina, from the George W. Vanderbilt estate. These tracts bring the total eastern forests up to 1,077,000 acres.

The production of anthracite coal again broke the record in 1913, exceeding the highest previous output by nearly 1,000,000 tons, according to figures compiled by E. W. Parker, coal statistician of the United States Geological Survey. Including the coal recovered from old culm banks and a small quantity dredged from Susquehanna River, the production of anthracite for the year was 81,718,680 long tons, valued at $195,181,127, compared with 75,322,855 tons valued at $177,622,626 for 1912. This is an increase of over 6,000,000 tons in quantity and more than $17,500,000 in value. The previous highest record was 80,771,488 long tons, in 1910. Anthracite miners and operators are now working under an agreement extending over a period of four years from April 1, 1912; there were consequently no serious interruptions to mining operations by labor troubles in 1913 and industrial peace is assured in the anthracite region until 1916. As the use of anthracite coal as a manufacturing fuel has been practically eliminated, its production is not affected by trade conditions to the same extent as that of bituminous coal. The increase in the use of artificial gas and of coke for domestic purposes will, in Mr. Parker's estimation, probably keep pace with the increase of population in the markets supplied by anthracite, and there is little probability that anthracite production will show any marked increase in the future. Another record in addition to that of tonnage was established in the anthracite region in 1913. The average working time for men, 257 days, exceeded anything in the history of the industry, the nearest approach being in 1911, when an average of 246 working days was recorded. In 1912 the average was 231 working days. The average number of men employed in 1913 was 175,745. Reports to the Bureau of Mines show that there were 618 fatal accidents.

UNIVERSITY AND EDUCATIONAL NEWS

The East London College (University of London) has received from the Drapers' Company about $75,000 to defray the cost of the erection and equipment of the new chemical laboratories of the college.

Dr. Herbert Stanley Birkett, a specialist in diseases of the nose, throat and ear, has been appointed dean of the medical school of McGill University.

At Vassar College the following appointments have been made: Aaron L. Treadwell, title changed from professor of biology to professor of zoology; Cora J. Beckwith, Ph.D. (Columbia, '14), promoted from instructor to assistant professor of zoology; Emmeline Moore, Ph.D. (Cornell, '14), instructor in botany, vice Assistant Professor W. J. Robinson, who becomes dean of the Women's Affiliated Colleges of Delaware; Elizabeth Cutter (Vassar, '11), Hazel Schmall (Colorado, '13), and Celia Jordan (Vassar, '14), have been appointed assistants in biology.

Dr. H. E. Ewing, Ph.D. (Cornell, '11), and Assistant Professor V. I. Safro, B.S.A. and postgraduate (Cornell, '09), have resigned from the Oregon Agricultural College, department of entomology. The present organization of the department is as follows: H. F. Wilson, M.S. (Oregon Agr. Col., '13), entomologist; A. L. Lovett, B.S. (Okla. Agr. Col., '10) and G. F. Moznette, B.S. (Oregon Agr. Col., '14), assistant entomologists.

Dr. F. R. Miller, of the department of physiology, McGill University, has been appointed professor of physiology in the Western University, London, Canada.

Mr. Ielson C. Dale, of the graduate college of Princeton University, has been appointed associate professor of geology at Hamilton College.

Following the retirement of Professor J. M. Thomson, Professor H. Jackson has been appointed head of the chemical department at King's College, with the title of Daniel professor of chemistry in the University of London.

Professor A. W. Crossley has been appointed to a university chair of chemistry, tenable at King's College.

DISCUSSION AND CORRESPONDENCE

THE CONFERRING OF THE BACHELOR'S DEGREE UPON NON-GRADUATES

The question of giving degrees to non-graduates who for various reasons have failed to obtain them while resident students is one that faculties of colleges and technical schools are frequently called upon to decide. Every year students leave college because of illness, financial embarrassment, lack of interest, defective scholarship and sometimes misconduct.

Some of them enter other institutions or subsequently return to their own college, and, after fulfilling all requirements, receive their degrees. Others enter business or professions in which they become so occupied that they find it impossible to take the time necessary for the completion of their collegiate residence and training.

Such men often attain distinction in their professions or prominence in other ways, and apply for degrees, being urged thereto by some admiring former classmate, or at the solicitation of some member of the faculty, who is enthusiastically appreciative of their continued interest, financial or otherwise, in the college. It is not easy to understand why one who has attained distinction in his profession should seek an undergraduate degree when such degree signifies nothing beyond the fact that the possessor, prior to his entering his profession, has completed a prescribed course of study in preparation therefor.

The applying for and the granting of a degree on any other basis than its being earned puts an abnormal importance on the degree itself and stamps the recipient with a misleading trade-mark.

Investigation shows a wide variation in this practise among prominent universities, colleges and technical schools. Some grant no degrees except for the completion of a prescribed course in residence; others accept a certificate for the performance at another institution of such part of the work or its equivalent as the candidate may lack; and then there are some which grant degrees on a minimum residence of two years with "fair" standing, honorable dismissal and a "creditable" record varying from ten to twenty-five years subsequent to leaving college.

During the past two years this question of granting degrees to non-graduates has been repeatedly brought to the attention of the faculty of the Worcester Polytechnic Institute and a committee was appointed to investigate the matter. In order to ascertain the practise in other institutions a circular letter asking for information was sent to all universities, colleges and technical schools on the accredited list of the Carnegie Foundation. Also a letter was sent to most of the graduates of the Worcester Polytechnic Institute who have been or are now engaged in teaching, to ascertain their views on the question. This committee after careful consideration of all the information which had been assembled brought in a report which was unanimously adopted by the faculty. Since a number of institutions with which the committee corresponded expressed the desire to be informed as to the conclusions reached, it has seemed best to publish the whole report.

REPORT SUBMITTED TO THE FACULTY OF THE WORCESTER POLYTECHNIC INSTITUTE

The committee to which was referred the question of providing some means whereby degrees may be conferred upon non-graduate students submits the following report:

1st. That the committee recommend that the degree of Bachelor of Science be conferred only on those who have completed one of the courses of study prescribed at this institute as leading to that degree.

2d. That in the opinion of the committee it is not wise to grant any honorary degree to a non-graduate; but in the opinion of the committee the names of all former students should be printed in some official publication of the institute.

The general reasons which have influenced the

committee in making the recommendations are as follows:

1. We have great respect for those who have left the institute without completing a course and have nevertheless been successful in their profession; but we do not believe that, in general, such men feel the need of a degree or wish the institute to lower its present high standing among engineering schools by granting unearned degrees.

Replies to inquiries sent to all of our graduates, who are engaged in educational work and who are in a position to feel the responsibilities and appreciate the importance of maintaining collegiate standards, show that there is no general demand on the part of graduates that such degrees should be granted and that many graduates are strongly opposed to the plan.

2. A Bachelor's degree as granted by an engineering school is essentially a certificate that the recipient has completed a course of study in preparation for the practise of engineering. Such a certificate can not honestly and honorably be granted to one who has not completed the work specified as necessary.

3. It does not seem possible to devise any method of granting the Bachelor's degree to one who has not completed a specified course of study, without lowering the value of the degree for the regular student and for those who have fully earned the degree.

4. If the definite requirement of a completed course of study were once abandoned there would be no definite halting point in the process of reducing the arbitrary and fluctuating requirements that might from time to time be substituted. The result would probably be an undignified struggle to modify the requirements so as to meet exceptional cases and in the process we should be likely to cause as much disappointment as satisfaction among our non-graduates.

5. We have received information from 60 of the prominent universities, colleges and technical schools as regards their practise in the matter. Of these, 44 do not confer the Bachelor degree on any one who has failed to complete a prescribed course; 14 grant degrees with more or less regularity on the basis of subsequent merit, one has granted two such degrees and one has granted degrees in two instances for a large amount of subsequent research.

A study of the replies leads us to believe that in general the institutions which grant unearned Bachelor's degrees find the system a source of difficulty and dissatisfaction and some of the replies are decidedly apologetic and defensive.

We believe the existence of such a system is a discredit to higher education in general and that the movement is away from it. One leading university has already abandoned it after long trial, and another is endeavoring to get rid of it. We think that it would be a serious mistake for the institute at the present time to adopt what we regard as a discredited and discreditable practise.

W. L. JENNINGS

MULTIPLE FACTORS VS. "GOLDEN MEAN" IN SIZE INHERITANCE

GROTH'S preliminary note on the "golden mean" in the inheritance of sizes in SCIENCE of April 17, 1914, pp. 581–584, deserves the attention of geneticists. Its publication is of such recent date that I need only call attention to one or two points that seem to me of particular moment.

In brief, Groth's hypothesis is that the mode of inheritance in F_1 not only of surfaces and volumes, but also of linear dimensions is to be expressed by $\sqrt{ab}$ rather than by $a+b/2$ where a and b are parent sizes. The hypothesis is based upon measurements of a large number of tomato fruits of parental and F_1 plants. It will certainly be worth determining whether Groth's expression fits size characters in other plants. A hurried examination of data, both published and unpublished, derived from my own studies of seed size in beans and maize, indicates that F_1 sizes are nearer the average than the geometric mean of the parent sizes. But my object now is not to lay stress upon any possible agreement or disagreement between my results and those of Groth. It is rather with the relation of Groth's hypothesis to the idea of multiple factors that I am here concerned.

That Groth's hypothesis is essentially Mendelian is shown by the fact that his size factors are assumed to segregate in equal numbers in the gametes of F_1 plants. That he regards his hypothesis as entirely unlike

the multiple factor hypothesis is indicated clearly by these statements:

> We know that size characters do segregate in the F_2, but we admit that with them the simple Mendelian ratio of 1:2:1 is never realized, though in large populations the parental sizes may reappear. Mendelians commonly try to account for the complicated ratios by assuming the presence of multiple factors; non-Mendelians point to the same ratios as quasi-evidence against Mendelian inheritance. I offer a different explanation.

By way of conclusion, Groth further remarks:

> The finding in the F_2 or later generations of lines which breed true to size characters is thus not proof of the presence of multiple size factors in the original parents.

It is evident, however, notwithstanding Groth's disavowal, that his hypothesis is distinctly a multiple factor one. His suggestions as to how spherical fruited parent races, the dimensions of whose fruits are $4 \times 4 \times 4$ and $9 \times 9 \times 9$ respectively, might combine to produce F_1 fruits of dimensions $6 \times 6 \times 6$ is rightly regarded as having a bearing "beyond furnishing an explanation of partial dominance in F_1." It might seem at first that he regards volumes as the inherited units and that volume, together with a shape factor, controls linear dimensions. This is evidently not, however, his idea. In the cross noted above for illustration, a gamete bearing a length factor 9, a breadth factor 9 and a thickness factor 9 differs from a gamete bearing a length factor 9, a breadth factor 4, and a thickness factor 9 or 4 with respect to its effect not only upon the volume of the resulting fruits but also upon the length of those fruits. The postulated spherical shape factor, which is common to all gametes, but which modifies the common length factor 9 only in case the breadth or thickness factors are other than 9 and does not modify it in case these breadth and thickness factors are 9, is certainly somewhat confusing. But to say that a length factor 9 produces an effect equal to 9 in length when the breadth and thickness factors are also 9 and produces some other effect on length when the breadth and thickness factors are other than 9 is merely the equivalent of saying that the breadth and the thickness factors have an effect upon length and are thereby length factors. This makes three factors for length—a typical multiple-factor hypothesis.

Again, if the presence of the somewhat fanciful shape factor be insisted upon, we are still dealing with multiple factors. In his illustration, Groth assumes two length factors, 4 and 9 and a shape factor that modifies them under certain conditions. This makes three factors affecting length. We can not limit the length factors to the two, 4 and 9, and say that the third factor assumed to modify length is nevertheless not a real length factor merely because we have chosen to call it a shape factor. Genetic factors for any character are the inherited units that have an effect upon the development of that character. The fact that some of them may also be concerned in the development of other characters, while really important, is immaterial in this connection.

It was said above that a shape factor affecting length, plus the two length factors 4 and 9, make a complex of three multiple factors for length. As a matter of fact there are more than three such factors, if we hold to the shape factor. The shape factor was shown to modify length only in certain cases, namely, when the breadth or the thickness factor is not of the same value as the length factor. In other words, the ability of a shape factor to modify length is influenced by the presence of breadth and thickness factors and the latter thereby become at least indirect length factors. But who, in the present state of our knowledge, can say that the assumed primary length factors 4 and 9 are less indirect in their effect than are the other factors influencing length?

I do not wish to appear too critical of Groth's suggestions. It is only by a careful analysis of such novel suggestions that we can hope to gain a better understanding of how genetic factors behave. My purpose is merely to aid in such an analysis.

R. A. Emerson

University of Nebraska

THE GOLDEN MEAN

TO THE EDITOR OF SCIENCE: With reference to the article on the "Golden Mean" in your issue of April 17, may I recall the fact that in a letter which appeared in Vol. XXXII., p. 625, I showed that the mean of the F_1 offspring of two families crossed at random is, on certain assumptions, the geometric mean of the parental averages. I confess that I can not bring Mr. Groth's results for crossing individual plants into line with the theory propounded in my letters, but, at any rate, it is suggestive that a theoretical reason for the appearance of geometric means in connection with inheritance can be given.

A. B. BRUCE

LONDON,
May 5, 1914

DISAGREEMENTS IN CHEMICAL NOMENCLATURE

THE number of SCIENCE for January 23 contains an article by Dr. F. W. Clarke which undoubtedly strikes a sympathetic chord in the majority of American chemists. That any chemical element should be given different names by two groups of chemists is indeed lamentable, the more so that each of these groups contains many scientists of enviable reputation who naturally would be expected to place themselves far above the petty jealousies which characterize many societies of less learned persons.

That a scientist who contributes to the known knowledge of chemistry to the extent of discovering a new element should not be granted the privilege of naming that element is anything but just. The columbium-niobium controversy is an excellent example. The discoverer of the element named it columbium; others later took it upon themselves to rechristen the element. The columbium-niobium controversy is not in the least a question of which is the better name—it is a question of bestowing any honor incident to the discovery upon the one to whom it belongs.

But this is merely one of several cases of disagreement in names. In 1798 the French chemist Vauquelin discovered a new element while working with the mineral beryl. Unfortunately Vauquelin did not suggest a name for this new element but he did note that the oxide is characterized by a sweetish taste. On account of this property the editors of the *Annales de Chimie,* the journal in which Vauquelin described his discovery, at once suggested the name glucina for the new earth. The name was immediately adopted by the French. Later the German chemists adopted the name beryllium which they have retained ever since. At the present time the German and Spanish chemists use the name beryllium while the original name glucinum, given by the French, is used by the French, Russian and Italian chemists. Among English chemists as well as those of America, both names are in rather common use. In glancing through twelve chemical text-books in English, all supposedly of college caliber, the author finds that seven make use of the name glucinum whereas only three give preference to the name beryllium. One apparently gives no preference and one does not mention the element except in the table of international atomic weights in which it appears as glucinum. In the publications of the United States Geological Survey the name glucinum is used.

The index of the *Journal of the American Chemical Society* for the year 1904 contains references to articles on beryllium but none on glucinum. For the year 1905 the index likewise contains references under the name of beryllium only, notwithstanding that one of the articles referred to is a note on the atomic weight of glucinum and does not mention the other name. The index for 1906 contains three beryllium references and one glucinum, while those for the years 1908 and 1909 contain beryllium only. In the *Abstract Journal,* four beryllium articles and one glucinum are indexed for the first year, 1907, while the index for 1908 contains references to several beryllium articles and also to several on glucinum. In the volumes of the *Abstract Journal* which have been issued since 1908, the name beryllium alone is used regardless of the name which appeared in the various articles abstracted.

The element tungsten is the subject of a still more exaggerated disagreement. Scheele was unquestionably the first to mention this element, stating that he had found, in the mineral then known as tungsten but now called scheelite, a new acid to which he gave the name tungstic acid. Two years later, in 1783, it was noted by three Spanish chemists, the d'Elhujar brothers, that the new acid is also present in the mineral wolframite. The German name wolfram was derived from the name of this mineral. At the present time the element is known as wolfram by the Russian and German chemists while the English, French, Spanish and American chemists employ the name tungsten. It is interesting to note that the English and American chemists, although clinging to the historically more correct name, unanimously use the symbol W for this element. On the other hand, the French not only employ the name tungsten but represent it by the symbol Tu.

Still another interesting example. Rutherford and Priestley in 1772 independently demonstrated that after a time an enclosed volume of air no longer supports combustion or respiration. Lavoisier, however, was the first to recognize that this residual air, after removal of the carbon dioxide, is a simple body. On account of its inability to support life, he immediately named the gas azote, deriving the name from a Greek expression meaning literally antagonistic to life. The name nitrogen which the element now commonly bears was first suggested by Chaptal. At the present time the chemists of France and Russia still cling to the original name azote with the symbol Az, while to the chemists of most other nations the element is nitrogen. Nevertheless we still have in English a few relics of the original name, as for example, the names hydrazoic acid, hydrazine, azine and azole.

The adoption or use of a name other than the one originally given to an element by its rightful discoverer is by no means an indication that the discovery is discredited. Although the German chemists unanimously employ the name wolfram, they nevertheless do not hesitate to attribute the discovery to Scheele. Again, these same chemists invariably concede Hatchett to be the discoverer of columbium, although they have substituted and use the name niobium erroneously given to the element by Rose some forty years later. In all probability the greatest argument which the chemists of certain nations can offer to-day for endorsing the name niobium is the common use which that name has had in their respective countries since the days of Heinrich Rose.

It is unfortunate indeed that there should be lack of unity amongst scientists as to the names and symbols for such fundamental bodies as the chemical elements, but it is still more unfortunate that the chemists of any one land should be divided in their selection of a name for an element as we Americans are with respect to glucinum. A solution of the entire question of names and symbols could be brought about by the appointment of an international committee definitely instructed to waive all petty jealousy and, in a spirit of all fairness, diligently to search the literature, consider all claims of priority and finally report on the original and therefore most proper name for each element. That the chemists of various nations would agree to the appointment of a committee so instructed is entirely possible but very improbable. Furthermore, it is extremely doubtful if a report submitted by such a committee would be adopted by more than one third of the chemists of chemical societies to-day. It would, however, be a comparatively simple matter for American chemists to intrust the settlement of this question to a carefully chosen committee in order that we Americans might use uniform names and symbols although unable to agree entirely with the chemists of other nations.

H. B. NORTH

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THE PROFESSOR AND THE INSTITUTION

IN America, we have in name freedom of speech; in fact there are considerable areas of

matters vital to human welfare discussion of which is socially and publicly taboo. We have in name freedom of the press; in fact journalistic intelligence is narrowed in its expression by public indifference and muzzled by the private interests of private owners. I suppose that the artist's right to express his own soul is theoretically conceded; but I am confident that any artist who should attempt Gallic liberties in his self-portrayals would but placard his name to distrust and put his genius in perpetual quarantine. The case of the teacher who happens to be also a thinker is better than these chiefly from the circumstance that his right to express his thought is a more present issue and is likelier to come to an early solution.

The issue of "academic freedom" is the problem of adapting institutionalism to personalities. Education has become an involved affair, with elaborate "plants," ornate administrations, and a distinguished sense of what the eloquent speech of Manhattan would call its "front." Few, I imagine, doubt the utility of these perquisites; while none conceding this can question the importance of the institution or the high sufficiency of its administrative avatars. And yet if the institution of education becomes too gross of organization, it loses the end of education. Perfunction is the oil that smooths administration, but it clogs and dams personality; and education apart from personalities, in place of a Socratic mid-wifery to souls, becomes the deft art of spiritual undertakers—the school is replaced by the morgue. Our danger is obviously lest the instrument kill the growth it was designed to foster.

Putting the matter concretely, education, as it is nowadays conceived, has two requirements different to the point of antagonism. On the one hand there is the need for elaborate material and financial equipment, and with it all the accompanying interplay of institution and public. This is a problem of ingenious government and politic administration, demanding for its success an essential solidarity. On the other hand, if the function of the institution is to be fulfilled, the right of the teacher to think and to speak his thought must be subject only to his own wisdom—at least within the province of his subject; and this spells essential individuality. Thus we are presented to a dilemma, with horns equally brazen.

Doubtless the ideal solution would be the creation of a breed of teachers gifted with a military scorn of danger and a high indifference to economic death. There is, as the matter stands, a lingering suggestion of effeminacy about the professorial craft. Men generally suspect in the professor a deficient virility, and they look upon scholarship as a kind of spiritual cosmetic designed to conceal an enfeebled soul. It might habilitate the teacher's profession in the general eye, and perhaps enhance the teacher's own esteem of it, if the business were made perilous and publicly spiced with rash braveries of expression. But the difficulty of this heroic road is that only the tame would be left to teach. Eventually—and in no long eventuality—it would destroy the schools.

What is needed is clearly a compromise (and let not the term be regarded as a sign of fear; all practicalities are compromises, and language, the most practical of all is the most compromising of all, for every word is a compromise of its meanings). The institution, in its essential solidarity, is necessary to the professor; the professor, in his essential individuality, is necessary to the institution. This mutual necessity must surely yet mother a thrifty progeny.

Every one interested in the situation has, I suppose, his scheme of melioration. I have mine. Let me briefly sketch it. I am speaking, be it understood, of colleges and universities.

Suppose that in each institution there were a clear legal distinction between the professoriate and the administrative body. In the hands of the latter should rest all problems of organization, publicity, expansion or contraction of curricula, material control, and all appointments except to the professoriate; it

should have in its hands the essential conduct of the institution, as at present. Only one power which it now has it should not have: the direct power of appointing or of removing a "professor." For the professoriate should be composed just of the men bearing the title "professor," whose rights should be: (1) Appointment only on election by the professoriate, according to its own rules of election. (2) Removal only after trial by the professoriate, according to its own rules. (3) Assurance of a certain minimum salary—determined by the custom of the institution—so long as the title of "professor" remain unrecalled; and (4) assurance of the right to teach the subject defined by his complete title, during the like period.

Under such a division any administration could impeach any professor, demanding his trial by the professoriate, but it could not remove him until this trial had resulted in the revocation of his title. On the other hand, no professor would be allowed administrative control of any department or school except on appointment to such work by the administration. Further, there should be allowed various titles, such as "assistant" or "associate professor," to be given by the administration to men to whom it wished to encharge work newly introduced as well as by the younger men who might be regarded as candidates for the rank and position of "professor." These men, in each institution, would be serving a probation, preliminary to their final election to the body of the professoriate. There should be nothing to prevent the administration from paying such men even higher salaries than the professorial minimum, and indeed nothing to prevent any advance in salary to a "professor" above this minimum. Of course any "professor" should be eligible to any administrative office without sacrificing his professorial rank and rights.

This scheme, viewed *a priori,* ought to be easy to introduce and maintain. A charter body of professors should be selected from the staff already in service by the administration of each university and college, and contractually endowed with the rights named. Presumably, the body so selected would represent the present sentiment and ideals of the institution, while the natural conservatism of a self-perpetuating body would ensure a reasonable constancy in its character. Young men would be tried out before being elected to the body; while the administration would retain ample power to guide the general development of the institution.

Our present plan, in which the head of the institution is, internally to it, the benevolent autocrat, and, externally to it, the responsible politician, is an ugly makeshift. The plan here proposed ought to lighten the cares of such a head by lessening his responsibilities, while at the same time it would relieve the professorial profession of the stigma of servility, and it would give the supporting public a less flickering consciousness of the fact that in calling a man to the thankless task of thinking they are incurring obligations as well as receiving benefits.

H. B. Alexander
University of Nebraska

SCIENTIFIC BOOKS

The Antiquity of Man in Europe, being the Munro Lectures, 1913. By James Geikie, LL.D., F.R.S. Pp. xx + 328, 9 text illust., xxi pl. and 4 maps.

This is a series of lectures upon a subject with which Professor Geikie's name has been associated for more than a third of a century. His "Prehistoric Europe" appeared in 1881 and the matter received more than incidental consideration in the third edition of his "Great Ice Age." The work is an argument from the geologist's standpoint, the most important of all, since geology is the final court of appeal.

The subject is outlined in the first lecture. The general features of Pleistocene climate and its extreme variations are shown in a discussion of the several faunas and floras, which affords opportunity for comparison with present conditions in Asia and North America. He is led to believe that, while there is ample proof that man existed early in the Pleistocene, there is thus far no positive evidence of his

existence during the Tertiary. Having outlined his plan, he examines the kinds of evidence. Two lectures are devoted to the testimony of caves, in which the investigations are summed up with critical notes upon the reported observations. He indicates clearly the gaps in the record, but he emphasizes the association of paleolithic man with an extinct fauna and flora, the definite proof of successive extreme variations in the continental climate, the differing types of men during the several stages and their notable gradation in civilization as proving the great length of time which has elapsed since the first cave man appeared in Europe. The testimony of river drift deposits, especially those of Great Britain and France, is the topic of another lecture. The complex problem involves the deepening of valleys by river-cutting, the deposition of gravels, the origin of loess. The difficulties here are conceded frankly, but the deficiencies in this record do not coincide with those in that of the caves; the two records are supplementary.

The testimony of glaciers, as one would expect, is discussed in abundant detail. In this portion, composing nearly one half of the volume, the wholly new material derived from the author's later studies in many regions is very great. The movements of glaciers, their scouring and eroding power, their extent, the nature and distribution of moraines, the truncated valleys of the Alps are discussed in the light of recent determinations by the author and others. All go to show the immensity of the period during which man has been on this globe. The comprehensive study of local and general features, which is presented in these four lectures, contains much that can not fail to interest American glacialists, for some of the phenomena cited from Great Britain and the Continent are familiar topics in our literature.

Having laid his foundation, the author, in his closing lectures, sums up Pleistocene history as relating to man. The terms for the epochs differ in several cases from those given in the Great Ice Age, some changes having been made in the interest of accuracy and euphony. The epochs as defined in this volume are these:

First Glacial epoch, the Scanian of northern Europe, the Günzian of the Alps; First Interglacial epoch, the Norfolkian; Second Glacial epoch, Saxonian of northern Europe, Mundelian of the Alps; Second Interglacial epoch, the Tyrolian (replacing Helvetian); Third Glacial epoch, Polonian (replacing Polandian) of northern Europe, Rissian of the Alps; Third Interglacial epoch, the Dürntenian (replacing Neudeckian); Fourth Glacial epoch, Mecklenburgian of northern Europe, Wurmian of the Alps; Fourth Interglacial epoch, the Lower Forestian; Fifth Glacial epoch, the Lower Turbarian; Fifth Interglacial epoch, the Upper Forestian; Sixth Glacial epoch, the Upper Turbarian.

The oldest human remains are assigned to the first interglacial epoch; the Chellean and Acheulian stages to second; the Mousterian stage began during the third glacial and ended during the third interglacial; while the Aurignacian, the Solutréan and Magdalenian stages were within the fourth glacial. Paleolithic man's disappearance was abrupt and with him the associated fauna passed away. Neolithic man's appearance seemed to be equally abrupt and the modern fauna accompanied him. A partial bridge over the gap is afforded by the Azilian stage of southern France and Germany, which belongs very near the Lower Forestian or fourth interglacial epoch; at that time, Neolithic man was in Scotland.

Professor Geikie's work does not lend itself readily to review for it is a model of directness and compactness in statement. The discussion is judicial; facts are presented so skillfully that they appear to form a consistent argument and when the conclusions are reached, they have been anticipated by the reader as the only ones possible. Among glacialists there are those who will continue to dissent from the author's subdivision of the Pleistocene and from the extreme length of time which he assigns to that period; but all must agree with his final statement that when one considers that man has seen all those changes of climate, which caused repeated succession

of steppes, tundras and forests in the same region, he must recognize that the time has been very long—so long, that the few thousands of years since history began seem insignificant in comparison.

John J. Stevenson

The Psychology of Management. By L. M. Gilbert, M.L., New York, Sturgis and Walton. 1914. Pp. 344. $2.00 net.

The gap between psychology and industry is being bridged both by psychologists, who write of industry, and by industrial engineers, who attempt to point out the psychological laws underlying the success of their practise. This book is of special interest since it is written by a woman worker in an industrial laboratory where the give and take of psychology and technology is being encouraged in many interesting ways.

The book aims "not so much to instruct as to arouse an interest in its subject and to point the way whence instruction comes." In the mind of the reviewer, these aims are fully realized. The main theme is that modern form of management generally known as the "Taylor system." In this book the art of management attempts to become conscious and to develop or borrow a vocabulary. Management is defined as "the art of directing activity," and by the psychology of management is meant "the effect of the mind that is directing work upon that work which is directed, and the effect of undirected and directed work upon the mind of the worker." Such topics as the following indicate the general scope of the various chapters: selection of individual workers; proper instructions; functionalization of tasks; definition of duties and qualifications; motion studies and time measurements; analysis and standardization of task, tools, methods and materials; records, routing and work programs; the rôle of the various types of direct and indirect incentives (punishment, reward, prizes, bonus, profit sharing, etc.); welfare work; attitudes of employer and employee and their effect on work; methods and measurement of teaching; aids in learning; effective distribution of effort. Cooperation is urged in the accumulation of standardized industrial records for the purposes of psychological analysis.

As might be expected, the psychology of management, in its present state, shows several traits similar to those displayed by the science of education in its earlier days. In the present book, for instance, there is artificial systematization and an occasional lapse into discursive generality. There is a somewhat labored attempt to suggest forward movement in the thought by means of divisions and paragraph headings in the text; many paragraphs consist of a single sentence. There is an apparent attempt to give text-book form to a subject that is not yet ready for it.

In spite of these remediable features the book is a real contribution to applied psychology as well as to the work of the student of efficiency engineering. It well typifies the growing tendencies toward cooperation between science and practise and suggests a stimulating program for future work. Applied psychologists should not fail to make themselves acquainted with the Gilbreth laboratory.

H. L. Hollingworth

Columbia University

Monographien einheimischer Tiere. Bd. 5, Die Strudelwürmer (Turbellaria). Von Privatdozent Dr. P. Steinmann und Professor Dr. E. Bresslau. Pp. xi + 380, 2 pls., 156 figs. in text. Bd. 6, Tintenfische mit besonderer Berücksichtigung von *Sepia und Octopus.* Von Dr. Werner Th. Meyer. Pp. 148, 1 pl., 81 figs. in text (Klinkhardt, Leipzig).

The latest numbers in the admirable series of monographs prepared under the editorship of Professors H. E. Ziegler, of Stuttgart, and R. Woltereck, of Leipzig, both deal with animals widely used in experimental or in morphological work in the biological laboratories of our universities and colleges, and both are particularly welcome. The volume dealing with the turbellarians is doubly welcome, since no brief and comprehensive treatise has dealt with these easily obtained and widely utilized animals since Benham's (1901) short account in Lankester's "Treatise on Zoology." More-

over, we find in the volume in hand fuller treatment of four aspects omitted in Benham's, namely the ecological, the physiological, the experimental and the systematic, and these are as adequately done as are the morphological and embryological phases, indicative of the breadth and catholicity of current German biological scholarship. Under the head of "Biologie," for example, we find a discussion of such topics, among others, as locomotion, nutrition, food-taking, commensalism, parasitism, hunger, excretion, sexual and asexual reproduction, autotomy, regeneration in different species, influence of external factors in accelerating and inhibiting regeneration, form regulation, heteromorphosis, duplication, natural malformation, sensory reactions, foes and parasites. Both triclads and rhabdocœls are very fully treated. An abundance of simple diagrams truly illustrate the text, and a key to species, a glossary, and a bibliography complete it.

The work is exceptionally comprehensive in scope, though brief, and well-proportioned, as well as admirably conceived and worked out. If any criticism is to be passed upon it one might suggest that the illustrations are below the standard to be expected in German books, and that the experimental work of Morgan and his school, and the mine of information in Pearl's monographic treatise on the behavior of Planaria have been wholly overlooked, in fact, the sources as well as the "Tiere" appear to have been "Einheimischer."

The information pertaining to the Cephalopod type has been much more accessible, thanks to Brook's chapter in his "Invertebrate Zoology," to Bauer's admirable "Einführung" (1909) in the Naples "Mitteilungen" prepared especially for the assistance of experimentalists deficient in zoological training, to Isgroves (1909) monograph on *Eledone* and Williams (1909) on *Loligo*. Dr. Meyer's booklet is supplementary to these in that it deals with *Sepia* and *Octopus*, forms equally desirable as laboratory types. The work is very largely anatomical, a departure from the general scheme of the series, justifiable perhaps in view of Bauer's paper and of the fact that the devil-fish is never seen in living condition by the biological student outside of the seaside laboratory with ample aquaria, for cephalopods do not long withstand removal from the normal habitat. One expects a fuller morphological treatment of the kidney, the eye, the hectocotylus, the chromatophores and the phosphorescent organs, than he finds here, and in fact the whole treatise might have been elaborated in greater detail on both genera to the advantage of the reader. The discussion is direct, lucid and well-adapted to serve the purpose of an elementary introduction to cephalopod morphology.

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The Copper Handbook. By WALTER HARVEY WEED. Published by the author; Houghton, Michigan, 1914. Vol. XI., 1912–13. Pp. 1413. Price $5.00.

The "Copper Handbook," well-known to all those interested in copper mining, has been taken over by Mr. W. H. Weed, who has issued a new revised edition bearing the date of 1914. Since its establishment by H. J. Stevens in 1900 this useful compendium of information about the copper mines of the world has gone through ten previous editions. The reliable information and fearless criticism contained in it were greatly appreciated by mining men. Since the unexpected death of its founder in 1912 the work of preparing a much needed new edition has been undertaken by W. H. Weed, the well-known geologist and mining engineer, formerly connected with the U. S. Geological Survey. Mr. Weed has reduced the former unwieldy volume of nearly 2,000 pages to about 1,400, largely by the elimination of the introductory chapters on mineralogy, geology, mining and metallurgy, and by the segregation of the "dead" companies. The copper mines of North America are now described alphabetically in a first chapter which is followed by a much needed index by states and countries. The third section describes the mines of South America and other continents in alphabetic, non-geographic arrangement. Much new

information is given of copper mines in South America. The book is concluded with a résumé of statistical facts. A wealth of new information is given and much of the descriptive material is entirely rewritten, bringing the book up to date. The policy of frank criticism which has been such a valuable feature of the book in the past is evidently continued and it is safe to say that the "Copper Handbook" in this much-improved form will meet with the approval of those who seek information about the mining of this metal.

W. L.

EIGHTH LIST OF GENERIC NAMES (MAMMALS) UNDER CONSIDERATION IN CONNECTION WITH THE OFFICIAL LIST OF ZOOLOGICAL NAMES

28. Notice is hereby given to the zoological profession that the following list of sixteen generic names in mammals has been submitted to the International Commission to be acted upon under the plenary power authority, granted by the Monaco Congress, to suspend the rules in the Code of Nomenclature. This list is published herewith without comment and all persons interested in the subject are cordially invited to communicate with the secretary of the International Commission and to give him any arguments bearing on the subject.

29. In the following list the names are arranged in the following order: (*a*) preserve; (*b*) for; (*c*) genotype; (*d*) instead of; (*e*) see explanatory notes that follow list.

In accordance with the permission given to zoologists at the Monaco Congress to submit to the International Commission on Nomenclature names which are recommended for fixation by fiat, we the undersigned mammalogists beg to present the following sixteen names which we recommend as *nomina conservanda* in the class with which we are concerned. The general reasons for the presentation of such names have been so often published that we do not need to repeat them here:

(*a*) *Anthropopithecus;* (*b*) for chimpanzees; (*c*) type *A. niger;* (*d*) instead of *Simia* or *Pan;* (*e*) see note T.

(*a*) *Cercopithecus;* (*b*) guenon monkeys of Africa; (*c*) *Simia mona* Schr.; (*d*) *Lasiopyga;* (*e*) T. 1.

(*a*) *Chiromys;* (*b*) aye-aye; (*c*) *Sciurus madagascariensis* Gmel.; (*d*) *Daubentonia;* (*e*) 2.

(*a*) *Coelogenys;* (*b*) paca; (*c*) *Mus paca* Linn.; (*d*) *Agouti* or *Cuniculus;* (*e*) 3.

(*a*) *Dasypus;* (*b*) six-banded armadillo and allies; (*c*) *D. sexcinctus* Linn.; (*d*) *Euphractus;* (*e*) T. 4.

(*a*) *Dicotyles;* (*b*) peccaries; (*c*) *Sus tajacu* Linn.; (*d*) *Tayassu;* (*e*) ?.

(*a*) *Echidna;* (*b*) spiny anteater; (*c*) *Myrmecophaga aculeata* Shaw; (*d*) *Tachyglossus;* (*e*) 5.

(*a*) *Galeopithecus;* (*b*) Philippine colugo; (*c*) *Lemur volans* Linn.; (*d*) *Cynocephalus;* (*e*) T. 6.

(*a*) *Gazella;* (*b*) gazelles in modern sense; (*c*) *Capra dorcas* Linn.; (*e*) T. 7.

(*a*) *Hapale;* (*b*) marmosets; (*c*) *Simia jacchus* Linn.; (*d*) *Callithrix;* (*e*) T. 8.

(*a*) *Hippotragus;* (*b*) sable antelope and allies; (*c*) *Antilope leucophæa;* (*d*) *Ozanna;* (*e*) 9.

(*a*) *Lagidium;* (*b*) mountain chinchilla; (*c*) *Lagidium peruanum* Meyen.; (*d*) *Vizcaccia;* (*e*) 10.

(*a*) *Manatus;* (*b*) manatees; (*c*) *Trichechus manatus* Linn.; (*d*) *Trichechus;* (*e*) T.

(*a*) *Nycteris;* (*b*) the African bats usually so-called; (*c*) *Vespertilio hispidus* Schr.; (*d*) *Petalia;* (*e*) T. 11.

(*a*) *Rhytina;* (*b*) Steller's sea-cow; (*c*) *Manati gigas* Zimm.; (*d*) *Hydrodamalis;* (*e*) 12.

(*a*) *Simia;* (*b*) orangs; (*c*) *Simia satyrus, auct. nec* Linn.; (*d*) *Pongo;* (*e*) T. 13.

Cases marked with a T. involve, under the technical rules, the transfer of a name from one group to another.

Every name here recommended for legalization by fiat is well known to systematists, and universally used by general writers.

When a name is legalized by fiat, we consider that power may be assumed to fix the most classical form of the name, not necessarily that which was first used, *e. g.: Rhytina,*

not *Rytina; Chiromys,* not *Chieromys* or *Cheiromys.*

Purely consequential recommendations (*e. g.*, *Tatu* for the tatous, *Lasiurus* for the American hairy-tailed bats), are not inserted in the list.

Notes to the List

1. *Cercopithecus* has been invariably used for the gueonons up to 1911, and its transfer to the tamarins only depends on Gronovius, a doubtfully binomial writer.

2. *Daubentonia* is almost unknown to general writers, the use of *Chiromys* having been nearly universal.

3. The names objected to are both known in connection with other animals, and the use of either of them for the paca is most confusing.

4. Technically *Dasypus* ought to be transferred to the tatous.

5. *Echidna* has been used by all classes of writers. It would have to be withdrawn from ichthyology.

6. The use of *Cynocephalus* involves a particularly objectionable transfer.

7. An early reference by Pallas in connection with *Oryx gazella* makes it advisable to affix the name *Gazella* to the gazelles before it is attempted to be used for the gemsbucks.

8. The transfer of the name *Callithrix* from the titi monkeys (*Callicebus*) to the marmosets is highly confusing. The name should be dropped altogether.

9. *Hippotragus* has been widely used; *Ozanna* is practically unknown.

10. The use for the mountain chinchillas of *Vizcaccia,* the vernacular name of *Lagostomus,* is most objectionable.

11. By the technical rules *Nycteris* would have to be transferred to the American hairy-tailed bats (*Lasiurus*).

12. *Hydrodamalis* is almost unknown to writers of any class.

13. Specific name (*satyrus*) to be fixed as well as generic, the original *Simia satyrus* Linn. being a chimpanzee.

Signed: KNUD ANDERSON, ANGEL CABRERA, EINAR LÖNNBERG, R. LYDEKKER, PAUL MATSCHIE, OLDFIELD THOMAS, L. L. TROUESSART.

C. W. STILES,
Secretary International Commission

SPECIAL ARTICLES

THE IONE FORMATION OF THE SIERRA NEVADA FOOTHILLS, A LOCAL FACIES OF THE UPPER TEJON-EOCENE

ONE of the numerous problems of California geology is the correlation of the Tertiary (the superjacent series), of the Sierra Nevadas with the Tertiary of the Coast Ranges. Many geologists have written on the age of the auriferous gravels and their associated formations since the time of Whitney, but the age of these formations is still in question and their relation to the marine deposits of the Coast Ranges is unproved.

While collecting during the past two years for the department of paleontology, University of California, the writer has had opportunity for the study of the relationship of the Ione of the Sierra Nevadas with the marine Eocene of the Coast Ranges. His conclusions are based upon visits to four typical Ione localities, viz., Marysville Buttes, Sutter Co., Cal., vicinity of Oroville, South Table Mountain, Merced Falls, and the type locality near the town of Ione in the Jackson Quadrangle.

The conclusion from this study is that the Ione, in part at least, is marine and of Tejon-Eocene age. Marine fossils have been found in the upper portion of the Ione formation at Marysville Buttes, Oroville, South Table Mountain, Merced Falls and Ione. Apparently the same faunal zone, the *Siphonalia sutterensis* zone,[1] is represented.

In the study of the Eocene of the Marysville Buttes the writer's conclusion was that "the supposed marine Ione of Marysville Buttes is evidently Eocene." In the "Note on the Faunal Zones of the Tejon Group," the strata beneath the Older Basalt of Oroville South Table Mountain which Lindgren mapped as Ione, were correlated with the Eocene of the Marysville Buttes. Several of the fossils obtained from the strata beneath the Older Basalt were identical with those of

[1] Dickerson, R. E., "Fauna of the Eocene at Marysville Buttes, California," Univ. of Calif. Publ. Bull. Dept. Geol., Vol. 7, pp. 257–298, 1913. "Note on the Faunal Zones of the Tejon Group," Univ. Calif. Publ. Bull. Dept. Geol., Vol. 8, p. 23, 1914.

the Marysville Buttes. After visiting these two localities the writer was inclined to the belief that the Ione and Tejon had been confused in these places. Conclusive evidence has recently been obtained in the type locality of the Ione which demonstrates that this formation at that place is also merely a local facies of the Tejon-Eocene.

Turner[2] recognized three lithologic members in the Ione at its type locality:

(1) The lower portion, a white clay, resting upon this; (2) a white or red sandstone, and (3), then a light gray, clay rock. He described it as follows:

Along the western border of the metamorphic rocks is a series of nearly horizontally stratified, light-colored sediments, which were deposited in the waters that covered the Great Valley at the time the older auriferous gravels with interbedded pipe-clays accumulated in the river beds of the Sierra slope. This formation attains its maximum development in the area of the Jackson sheet. The lower portion of the series, composed largely of white clay, is well-exposed around Ione, whence the formation takes its name. Farther south the white clays are overlain by sandstone, above which is a fine-grained clay rock. The lower, white clay is in places quite free from grit and is used in making pottery. Other portions are sandy. The formation contains iron-ore and coal seams. The sandstone is used for building purposes. It is usually white, but at one quarry a brick-red variety, colored by finely disseminated hematite, is obtained. At other localities it is rusty and contains pebbles of white quartz, passing into a conglomerate. A peculiar hydrous silicate of alumina occurs abundantly in the sandstone in the form of cream-colored, pearly scales.

The clay rock occurring above the sandstone is light-gray, but usually more or less discolored. The fracture is, as a rule, irregular and the rock frequently contains minute, tubular passages. Under the microscope it is seen to be composed of fine particles of feldspar and fine discolored sediment, with occasional quartz grains. Analyses of two specimens gave 59 and 72 per cent. of silica and 4.8 and 1.6 per cent. of alkali.

The succession of white clay, sandstone and clay rock may not be constant throughout the entire area mapped as belonging to the Ione formation. It has been suggested that the white clay of the lower beds are formed from rhyolitic tuffs, in which case eruptions of rhyolite must have occurred at the beginning of the Ione epoch.

The thickness of the Ione formation is known partly by natural exposures, partly by boring. In Jones Butte the strata, protected from erosion by a lava cap, are 200 feet thick above Coal Mine No. 3. A boring at the mine is said to have penetrated sandy clay to a depth of 800 feet below the coal seam, which is 60 to 70 feet below the surface. Thus the Ione beds appear to be more than 1,000 feet thick at this point.

To the east of Buena Vista Peak the series has a visible thickness of 600 feet. The tableland south and southwest of Buena Vista is chiefly composed of the Ione formation, overlain by rhyolitic and andesitic tuff and Neocene shore gravels. The lower clay occurs at the east base of the tableland, and a patch of Ione sandstone caps Waters Peak, a little farther east, which has an elevation of about 900 feet.

The relation of the sandstone to the clay rock is finely exposed on the south side of the Mokelumne River, by the bridge north of Camanche. Here the sandstone forms the lower part of the bank of the river. The upper surface of the sandstone has a gentle westerly dip, and a little west of the bridge reaches the level of the river, which at this point is about 175 feet above sea-level. East of the bridge it rises at an angle of about 1°, reaching an altitude of 1,000 feet on the flat ridge just north of Valley Springs Peak. Along the banks of the Mokelumne west of Lancha Plana this sandstone attains a thickness of more than 100 feet.

Turner in describing the Neocene shore gravels states their relationship to the Ione as follows:

The most striking evidence of nonconformity, however, may be seen at the red sandstone quarry three miles southeast of Buena Vista. Here the Neocene shore gravels rest unconformably on the smooth, waterworn surface of the sandstone, which is red where quarried, but white at the northern end of the exposure. Waterworn bowlders of the white sandstone may be seen in the gravel. Southwest of the quarry the ridge is capped for a distance of more than a mile with the same gravel, which half a mile from the quarry contains a layer of andesitic detritus. At the extreme southwestern end of the ridge is a body of similar gravel, which also rests plainly on sandstone of the Ione formation.

2 Turner, H. W., Jackson Folio, California, U. S. Geol. Surv., p. 2, 1894.

All the localities described by Turner have been visited. At the last-mentioned locality, "the red sandstone quarry three miles southeast of Buena Vista," the writer obtained *Venericardia planicosta* new variety. *Meretrix hornii* Gabb, *Psammobia cf. hornii* (Gabb), *Glycimeris* sp., *Crassatellites* sp., *Turritella merriami* Dickerson, *Natica* sp. and *Clavella* sp. The *Venericardia planicosta* found here is the variety with the obsolete ribs. All of these forms were collected from the sandstone five to ten feet beneath the Neocene shore gravels. While the fauna is limited in species, it is typical of the uppermost, the *Siphonalia sutterensis,* zone of the Tejon. The sandstone member in this vicinity, with a dip of only one degree toward the west, attains a thickness of 250 feet. It rests upon the clay, an altered rhyolitic tuff which is only fifty to one hundred feet in thickness. This in turn rests upon the steeply tilted eastern dipping Mariposa slates of the bed rock series. The same sandstone occurs on the hill east of Buena Vista Peak, and with about the same thickness. A half mile east of this hill the lower clay member becomes appreciably thinner and is only 25 to 50 feet thick. On Waters Peak one half mile further east, the clay member and a good part of the sandstone member are missing and only the massive upper fifty feet of the sandstone member is found resting upon the eroded surface of the Mariposa slates.

The third member, the clay rock recognized by Turner, appears to the writer to be merely a decomposition product of a rhyolitic tuff. A rhyolitic tuff rests directly upon the sandstone member in the vicinity of Buena Vista Peak. The writer's opinion is confirmed by an examination of the strata as exposed in Jones' Butte. A clay rock was found resting upon the sandstone member. In certain places this rock was found to be an unaltered rhyolitic tuff.

From the above description it is seen that this formation appears to have been deposited by a sea which transgressed from the west. Two or more of the three members of the Ione are very persistent over the Jackson Quadrangle, the Lodi Quadrangle, the Sacramento Quadrangle, the Sonora Quadrangle, and they can be recognized readily by their lithologic characters, low westerly dip, and stratigraphic position beneath the andesitic tuffs and upon the Mariposa slates or other members of the bed rock series.

Until these three members were studied at the type locality, the relationship of the small area south of Merced Falls, which was mapped by Ransome and Turner as Tejon, to the adjoining Ione tuffs and clays was obscure. The clays, sand and tuffs exposed one mile west of Merced are lithologically identical with those of the lowermost member, and the red sandstone mapped as Tejon, found here, is identical with that of the second or sandstone member of the Ione of the type locality. The same condition evidently prevailed here as in the area between Waters Peak and Buena Vista Peak, that is, a deposition along the shore line of a rapidly transgressing western sea. In this sandstone, casts of *Cardita planicosta,* var. *hornii,* with obsolete ribs were found near the top. The authors of the Sonora Folio, Messrs. Turner and Ransome[3] describe this as follows:

"*Tejon formation.*—The only rocks referable to this period are a few isolated patches of light-colored sandstone which occur capping some low hills in the southwest corner of the quadrangle. South and southeast of Merced Falls are two level-topped buttes capped by this sandstone, which rests almost horizontally upon the nearly vertical edges of the Mariposa slates. The basal bed is crowded with angular fragments of the slate and with abundant pebbles of white vein quartz, while the upper beds are composed of a light-colored quartzose sandstone with frequent bands of small quartz pebbles. Marine fossils (*Venericardia planicosta*) are fairly abundant in the upper bed at the west end of the butte that lies one mile south of Merced Falls. These sandstones are overlain to the west by the light-colored sandstones of the Ione formation. The two series are probably not absolutely conformable, as the Ione beds transgress onto the rocks of the Bed-rock series farther north."

[3] Turner, H. W. and Ransome, F. L., Sonora Folio, U. S. Geological Survey, p. 2, 1897.

The above-mentioned sandstones, instead of "being overlain to the west by the light-colored sandstones of the Ione formation," are in reality stratigraphically higher. These sandstones have been worn away from most of this area and only a few residuals remain.

After this great erosion, andesitic tuffs and tuff breccias covered all. During the Pleistocene and Recent time much of the andesitic material has been removed re-exposing the older rocks beneath.

The Ione has been repeatedly correlated with the Auriferous gravels of the Sierras and the upper portion with the rhyolitic tuffs. It can no longer be doubted that the Ione is of the same age as the Rhyolitic tuff and the Auriferous gravels, and since the Ione is clearly Tejon-Eocene, the Auriferous gravels, their correlative, must be upper Eocene, at least in part and the land equivalent of the marine Tejon.

Roy E. Dickerson

THE INCREASE IN PERMEABILITY OF THE FROG'S EGG AT THE BEGINNING OF DEVELOPMENT AND THE PRESERVATION OF THE LIFE OF THE EGG [1]

Three years ago, it was observed that the unfertilized frog's egg could be made parthenogenetic by a momentary electric shock, and reasons given for supposing that the electric shock (or the spermatozoon in normal fertilization) increased the permeability of the egg.[2] Recently, I proved this supposition to be correct. The permeability of the unfertilized egg to NaCl was found to have increased on stimulating the egg with an electric shock (which caused it to begin normal development).

Several methods were tried for the quantitative estimation of sodium ions, but the results with such small quantities would not be considered trustworthy had they not tallied with the more certain results on the determination of chlorine ions with the nephelometer, and only the latter will be described here. The technique was as follows:

A "pregnant" female of *Rana pipiens* was washed in alcohol and then in water, pithed and opened. The eggs were removed from the oviducts without mechanical injury or contamination with blood or lymph. These eggs were washed 10 minutes in a large volume of H_2O[3] and divided into two exactly equal masses. Each mass was placed in 30 c.c. of H_2O and allowed to remain for 30 minutes while the jelly swelled. The water that had not been taken up by the jelly was analyzed and the $Na+$ and $Cl-$ found to be the same for both lots. Then lot 1 was stimulated by an electric shock from clean platinum electrodes[4] and lot 2 used as a control. 20 c.c. of H_2O were added to each lot and at the end of one hour this water was analyzed. There was more $Na+$ and $Cl-$ in the water from the stimulated eggs than the control, the ratio of $Cl-$ being 10 to 7. This is a very small difference, but it must be remembered that the salt in diffusing out of the egg is held for some time by the "fertilization membrane" and the thick jelly surrounding the egg. Consequently 30 c.c. of H_2O were added to each lot and allowed to remain eight hours to give time for the salts to diffuse through the jelly. There was now found three times as much $Cl-$ that had diffused out of the stimulated eggs as had diffused out of the control. Whether this increase in permeability is the *cause* of development has not been determined, but it is not restricted to the frog's egg, since I found the same true of the sea urchins' egg,[5] a fact which has been confirmed by Gray[6] at Plymouth.

The unfertilized frog's egg placed in fresh or distilled water continues to swell until death ensues. This death is probably caused by the swelling, and the latter by the osmotic pressure of the soluble substances contained within

[1] Preliminary note.

[2] McClendon, Science, N. S., Vol. 33, p. 629.

[3] H_2O means water redistilled in quartz.

[4] In about one minute all of the eggs had turned the black pole upward; 3 hours later the first cleavage began.

[5] McClendon, *Amer. Jour. Physiol.*, 1910, Vol. 27, p. 240.

[6] Gray, *Jour. Marine Biol. Assn. U. K.*, 1913, Vol. 10, p. 50.

the egg. The increased permeability allows the escape of NaCl and lowers the internal osmotic pressure, thus retarding the swelling and preserving the life of the egg.

The decreased swelling of the developing egg can easily be measured. Forty-six eggs were removed from the oviduct and 23 placed on the bottom of a dry glass dish and 23 in a similar one. They were covered with distilled water and the first lot stimulated with an electric shock[7] and the second lot used as a control. The longest and shortest diameter of each egg was measured and the mean of all of each lot determined. The mean diameter of the eggs of the first lot on an average of 30 minutes after stimulation was 1.47 mm., whereas the mean diameter of the control was 1.52 mm. This is in confirmation of the results of Biataszewicz and of Bachmann. Biataszewicz[8] says that the frog's egg momentarily shrinks immediately after fertilization, due to fluid passing out of the egg into the perivitelline space. This is probably due to the increase in permeability. The quantity of fluid in the perivitelline space immediately after fertilization is too small to be collected, but it accumulates during development due to absorption of water from the medium and finally can be removed with a very fine thin-walled capillary pipette. Bachmann thinks that the osmotic substances in this fluid are secreted by the suckers, but the fluid is more abundant in *Amblystoma,* which has no suckers. I found it to contain relatively large quantities of NaCl, considering the fact that the "fertilization membrane" is permeable to NaCl. In *Amblystoma* this fluid is in such abundance that one might hope to make a complete analysis. I found it to contain besides water and NaCl, an organic substance which greatly reduced the surface tension. A very slight Millon's reaction was obtained after evaporating the solution down to dryness. Although the perivitelline space is larger in eggs in distilled water than in tap water, after the space has once enlarged, it is not readily shrunken by salts in the medium. The diameter of the "fertilization membrane" of an egg taken from distilled water was 13 mm. It was placed in Ringer's solution (for mammals) and in two days it had decreased only to 11.5 mm.

Bachmann and Runnström[9] found that the osmotic pressure of the frog's egg dropped enormously on fertilization and they do not believe that this can be accounted for by loss of salt. They seem to consider the egg as a diphasic system in which the watery phase forms the main bulk of the egg. On the contrary, the frog's egg is a four-phase system in which the watery phase is a very small fraction of the total volume. The bulkiest phase consists of yolk platelets composed of lecith-albumin swollen with water. The oil droplets are small and pigment granules smaller. It seems probable that the watery phase, which I found to contain 85 per cent. water and which fills the interstices between the other bodies, would freeze first in freezing point determinations, and we may assume that Bachmann and Runnström determined the Δ and calculated the osmotic pressure of this phase. Since the watery phase is but a small fraction of the volume of the entire egg, the loss of only a minute quantity of NaCl would be necessary in order to greatly lower the osmotic pressure. It should also be noted that Bachmann and Runnström did not remove all of the jelly from the eggs before crushing and freezing them and, consequently, the calculated osmotic pressure for the fertilized eggs is probably too low. The unfertilized eggs which they used were taken from the ovary and were not surrounded by jelly.

Bachmann and Runnström suppose the reduction of osmotic pressure of the frog's egg on fertilization to be due to the adsorption of salts to the proteins, following a sort of "coagulation" of the proteins. If it is true that the salts are adsorbed after "coagulation" by fertilization, we might suppose that they would be adsorbed after coagulation by heat, which could be tested by experiment. 564

[7] The first lot rotated normally and, 3 hours later, began the first cleavage.

[8] *Bull. Acad. Sc. Cracow Math.-Nat.,* October, 1908.

[9] *Biochem. Zeitschr.,* 1909, Vol. 22, p. 390.

grams (about 50 c.c.) of ripe ovarian eggs of *Rana pipiens* were boiled in absolute alcohol and extracted with absolute ether and dried at 135°. They were then powdered and boiled in 200 c.c. distilled water slightly acidulated with acetic acid (free from salts) to coagulate the proteins, and filtered. The filtrate was evaporated down and both filtrate and precipitate charred and extracted and titrated for chlorides. The filtrate required 1.55 c.c. 1/10 normal $AgNO_3$, whereas the precipitate required but .2 c.c., which might be due to the small amount of filtrate held in the precipitate. It thus appears that very little if any salt was adsorbed. If all this chloride is NaCl it would make a .00756 molecular solution of the same volume as the egg. However, the osmotic pressure of the ovarian egg corresponds to that of a .166 normal NaCl solution. If this osmotic pressure is due chiefly to NaCl it must be confined to the watery phase which must equal .0455 or about 1/20 of the volume of the egg.

I found that frog's eggs lose NaCl continuously during their development in distilled water, hence they must be permeable to NaCl for some time after fertilization. This is in harmony with the fact that pure NaCl solutions are not so toxic to the frog's egg as to the eggs of many other animals. I found that those salt solutions which were toxic to fish eggs increased the permeability, but the fertilized frog's egg is already permeable.[10] Some of the older work on the effect of pure NaCl on the frog's egg might be objected to on the ground that the NaCl solution became contaminated by Ca contained in the egg jelly. Therefore I made a series of experiments in which small numbers of frog's eggs were washed for an hour in several liters of distilled water, and placed in several liters of pure $NaNO_3$ solution. Very dilute solutions were non-toxic. One tenth molecular solutions showed a toxic effect in 48 hours, but this may have been due to osmotic pressure, since the addition of 1.6 c.c. of a molecular $CaCl_2$ solution to the liter did not decrease the toxicity. The toxicity of all salts is not due entirely to osmotic pressure, since I found lithium salts to be slightly more toxic than sodium salts of same osmotic pressure.

[10] Although it is more permeable to water than to salts.

All of the abnormalities in the lesser toxic salt solutions which I have observed or found in the literature, are characterized by a retardation or failure of the white pole to segment. This is also true of abnormalities produced by centrifugal force or other mechanical agents applied to the unsegmented egg. This unsegmented white pole prevents or retards the downgrowth of the black cell layer, and in extreme cases leads to the so-called "lithium larvæ." These embryos may regenerate and become normal tadpoles. The more toxic solutions prevent segmentation of the white pole and cause swelling of serous cavities (pericardium) and a separation or loosening up of the black cells, accompanied by death of some of these cells (a condition called by Roux "framboisea"). This condition (also seen in fish embryos) occurs after the frog's embryo has partially regained its semipermeability, and may be due to an abnormal increase in permeability by the salt solution.

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Medical School,
University of Minnesota,
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DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

G. A. Hulett, Chairman
R. C. Wells, Secretary

Rapid Detection of Arsenic in Poison Cases by the Marsh Test: James R. Withrow.

It seems to have been the experience for a long time that the number of cases where arsenic is the poison used exceeds that of all other poisons combined. Certain and rapid detection is therefore a matter of much moment. Any effort to make old methods more certain and to eliminate possibility of error by contamination or to abbreviate, thus reducing opportunity for loss, are desirable. The Berzelius-Liebig modification of the Marsh test (1836) has long enjoyed confidence as one of most satisfactory tests. It requires for universal certainty of results the elimination of organic

matter. This is slow, tedious and furnishes much opportunity for loss or contamination. The Reinsch test (1841) is rapid and simple, using the minimum of added reagents. In its present form its results are uncertain and seldom removed from the region of doubt. It does not require the preliminary removal of organic matter. The present work is believed to have made the detection of arsenic much more certain by eliminating entirely the destruction of organic matter. The arsenic is secured on copper strips as in the usual Reinsch procedure. These strips are introduced into a "duplex" Marsh apparatus which has been devised in this work. By the "duplex" feature (two hydrogen generators) no arsenic is lost while displacing air from the generator containing the copper strips which possibly contain arsenic. The use of two generators can be dispensed with by introducing an extra reagent to dissolve the arsenic from the copper. Either procedure greatly reduces the time necessary for the detection of arsenic with all the precision of Marsh's method. The new procedure has already been tried with thorough satisfaction in two poisoning cases where the presence of arsenic was proven finally to be present by the older procedures. The new procedure consumes but an hour or two where the old ones consumed usually one or more days.

The Decomposition Voltages of Salts in Liquid Ammonia. I, The Ammonium Salts: H. P. Cady and C. A. Nash.

Adsorption and Stabilization: J. C. Blucher and E. F. Farnau.

Further experimental facts are adduced to substantiate Bancroft's stabilization theory of dyeing. These include examples of adsorption of dyestuffs and inorganic compounds on colloidal hydrous aluminium-, copper- and cobalt-oxides.

The Ideal Diffusion Coefficient and a New Fundamental Law of Diffusion: G. McP. Smith.

Further Observations on the Preparation of Selenic Acid and Selenates: Philip L. Blumenthal.

A Burette Calibrating Pipette: E. C. Foulk.

Preparation of a Standard Magnesium Salt Solution: E. C. Foulk and O. R. Sweeney.

Concerning the Atomic Weights of Carbon and Sulphur: Theodore W. Richards and C. R. Hoover.

In order to verify the silver-halogen standard of atomic weights by reference to a ratio entirely different, a precise quantitative comparison was made between sodium carbonate and silver. The purest sodium carbonate was fused in a stream of carbon dioxide. It was then with all possible care analyzed exactly with very pure hydrobromic acid, and the amount of silver needed to precipitate the bromine was determined as well as the weight of silver bromide. For every 10.59950 grams of sodium carbonate 21.5760 grams of silver were needed. Hence carbon according to the International Standard of Atomic Weights became 12.005, sodium being 22.995. If silver is taken as 107.871, carbon became exactly 12. These results are completely concordant with the usually accepted values concerning carbon and silver. The agreement is striking and affords a much-needed and very welcome confirmation of the whole fabric of our table of atomic weights. The investigation was continued by converting weighed amounts of the purest sodium carbonate into sodium sulphate. The results were concordant among themselves, but pointed to a somewhat smaller atomic weight of sulphur than that usually recognized, namely, 32.055, if silver is taken as 107.88. This research verifies in a striking way that published by one of the authors, twenty-four years ago. The technique of this work will be of great value to any one desiring to make exact acidimetric or alkalimetric analyses.

The Critical Point and the Significance of the Quantity b in the Equation of van der Waals: Theodore W. Richards.

In this paper many results (especially those of Kamerlingh-Onnes) were quoted to show that the apparent bulk of the molecules of gases must be supposed to change according to circumstances. It was pointed out that the magnitude and direction of this change is such as would be expected if the molecules and atoms are compressible, but, if this is the case, the reasoning of van der Waals, which infers that the bulk of the molecules is only one quarter of *b*, is no longer sound, for this reasoning assumes the incompressibility of the molecules. The present argument shows rather that the actual bulk of the molecules when uncompressed by collision or by the compressing effect of affinity must be much larger than has been supposed, indeed larger than the actual bulk of the liquid under ordinary conditions, and perhaps that assumed at the critical point. It was pointed out that the continuity between the liquid and the gaseous states may be supposed to exist, if at all, only at the critical point, and that the application of the equation of van der Waals to liquids is of doubtful significance. The critical temperature is defined by supposing that it is the point where

the kinetic vibrational energy of the molecules is just barely enough to separate them when the outside pressure (added to their own affinity) is just sufficient to bring, on the average, the molecular surfaces into contact. In conclusion, it is clear that this interpretation of these facts is in complete accord with the theory of compressible atoms. Indeed, the various phenomena concerned seemed to be thus explained better than in any other way.

The Present Status of the Absolute Standard of Pressure: Theodore W. Richards.

The object of this paper was to point out the fact that the absolute or C. G. S. standard of pressure is being more and more used by those actually having to do with the pressure-measurement. Various meteorologists, chemists, physicists and engineers are using it regularly; the United States Weather Bureau, the Blue Hill Observatory, and the Weather Office in England are adopting it as their method of recording atmospheric pressures for scientific study. There is still some conflict in nomenclature, but it is to be hoped that the proposal adopted by the International Congress of Physicists, at Paris, in 1900, and independently suggested by the writer, that the "absolute atmosphere" (or the pressure of a megadyne per square centimeter) should be called the "megabar" or "megabarie," will be generally adopted. This "absolute atmosphere" is 1.3 per cent. less than the old atmosphere, and is the pressure exerted by a column of mercury 750.1 centimeters high at 45° latitude and 0° Centigrade.

A Method for Producing a Reproducible Contact Potential between Liquids: E. P. Schoch.

The Relation between the Concentrations and the Potential of the Ferrous-ferric Pole: E. P. Schoch. (Lantern.)

New Electro-analytical Methods for Lead, Tin, Copper and Antimony: E. P. Schoch and D. J. Brown. (Lantern.)

Contribution to the Knowledge of the Actinium Series: Herbert N. McCoy and Edwin D. Leman.

Solutions of Some Formates and of Hydrogen Chloride in Anhydrous Formic Acid-gases of Apparent Agreement of Strong Electrolytes with the Mass Law: H. I. Schlesinger and A. W. Martin.

When the degree of ionization of solutions of sodium, of phenyl-ammonium, of potassium and of ammonium formates in anhydrous formic acid is calculated from the conductivities of these solutions, the values agree very closely with the equilibrium law up to concentrations, varying from 0.3 to 0.55 molar in the several cases. These electrolytes are highly ionized in this solvent, as shown by the ionization constants, which are 0.75, 0.74, 0.95, 1.15 for the salts in the order in which they are named. Hydrogen chloride also agrees with the law; its constant is 0.04. When the conductivities are corrected for the viscosity of the solution the agreement with the law is not found.

Vapor Tensions in Alcoholic Solutions: O. F. Tower and A. F. O. Germann.

This is a continuation of the work published in the *Journal* of the society, 1908, p. 1219. Vapor pressures were measured exactly as described in that paper by means of the Morley gauge. The new feature is the preparation of the solutions entirely out of contact with air. Methyl and ethyl alcohols were used as solvents, and, after being purified and then fractionated *in vacuo*, were distilled directly on to the solute. Potassium iodide, lithium chloride, benzil and tetramethylammonium iodide were the solutes employed. Curves drawn with the concentrations as abscissas and the lowering of the vapor tension as ordinates are fairly regular, those of the salts rising more rapidly with the increase in concentration than those of the organic solutes. The molecular weights of the latter, as calculated, are approximately normal, while those of the salts are about one half the formula value and do not vary much with the concentration. The work is being continued to see whether this last statement is confirmed by further experiments.

Arsenious Oxide as a Starting Material in Acidimetry: Alan W. C. Menzies and F. N. McCarthy.

Equilibria in the Systems, Water, Acetone and Inorganic Salts: Geo. B. Frankforter and Lillian Cohen.

An investigation is made of the isotherms at 20° of the systems, water, acetone salts. The salts used are KF, K_2CO_3, $CaCl_2$ and NaCl. The comparative efficiency of these salts in "salting" out acetone from an aqueous solution is determined. KF is the most and NaCl is the least efficient. The amount of acetone present in an aqueous solution can be determined by the formation of layers when the potassium fluoride is added to the solution. Within certain limits methyl alcohol acts as if it were water and will not interfere in this determination.

The Colorimetric Determination of Manganese by Means of Periodate: H. H. WILLARD AND L. H. GREATHOUSE.

The solution of manganese salt containing excess of nitric, sulfuric or phosphoric acid is boiled for a minute after addition of potassium periodate. The manganese is oxidized to permanganic acid, the periodic acid being reduced to iodic acid. Small amounts of hydrochloric acid are without influence, being quickly oxidized to chlorine. The concentration of acid above a certain minimum may be varied within wide limits. In the presence of iron, sulfuric or phosphoric acid must be present to prevent the precipitation of ferric periodate. By means of a colorimeter, the solution is compared with a standard similarly prepared.

Electromotive Behavior of Soluble Sulfides: R. C. WELLS.

From a study of the potentials shown by various solutions of sulfides with a platinum electrode it was concluded that the electromotive behavior of the polysulfides depends on the relative proportions of the sulfides present, but that in acid solutions where free sulfur is apparently the only oxidation product of sulfide ions the potential of solutions which are very slightly oxidized can be expressed by the equation

$$E = -0.26 - 0.029 \log[s^{--}],$$

since the concentration of the free sulfur is constant and equal to its solubility in water.

The Phase-rule Investigation of Addition Reactions: JAMES KENDALL.

The freezing-point modes of the two-component system dimethylpyrone-acid have been examined for a large number of organic acids and phenols. The existence of thirty-seven addition compounds has been demonstrated. The results obtained are discussed in their bearing on the constitution of dimethylpyrone and the quadrivalence of oxygen. The reaction is considered to be ionic, and the compounds formed to be true oxonium salts. The method is generally applicable to the study of organic addition reactions.

Peculiar Action of Iodine: CHARLES T. P. FENNEL.

Distribution of Caffeine and Antipyrin Between Chloroform and Aqueous Solutions: W. O. EMERY AND C. D. WRIGHT.

Reaction in Non-aqueous Solvents: O. L. BARNEBEY.

Separation of Potassium from Sodium by Extraction of their Chlorplatinates with Acetone: O. L. BARNEBEY.

Some Compounds Belonging to the Ammonia System of Acids, Bases and Salts: E. C. FRANKLIN.

(1) *The Action of Potassium Amide on the Amides of Silver, Barium, Strontium, Calcium, Lithium and Sodium.* By Edward C. Franklin. It will be recalled that the writer and his collaborators have prepared compounds of the formulas,

$Sn(NK)_2 \cdot 4NH_3$, $Zn(NHK)_2 \cdot 2NH_3$, $PbNK \cdot 2\frac{1}{2}NH_3$ and

$$N \equiv Ti - NHK,$$

to which, in view of the analogy existing between these compounds as derivatives of ammonia on the one hand, and the stannate, zincate, plumbite and titanate of potassium as derivatives of water on the other, have been given the respective names, potassium ammonostannate, potassium ammonozincate, potassium ammonoplumbite and potassium ammonotitanate. Furthermore it will be remembered that similar ammono salts containing thallium and magnesium have been prepared, an accomplishment which is noteworthy in view of the fact that the corresponding aquo salts are unknown. It now appears that not only are the above-mentioned salts formed in a manner similar to that used in the preparation of potassium ammonozincate but that also the amides of silver, barium, strontium, calcium and even lithium and sodium enter into reaction with potassium amide in solution in liquid ammonia to form sharply defined products of the respective formulas,

$AgNHK \cdot NH_3$, $BaNK \cdot 2NH_3$, $SrNK \cdot 2NH_3$, $CaNK \cdot 2NH_3$, $LiNK_2 \cdot 2NH_3$ and $NaNK_2 \cdot 2NH_3$. If the compound, $Zn(NHK)_2 \cdot 2NH_3$, is properly designated as potassium ammonozincate, and it certainly is if the compound $Zn(ONa)_2 \times H_2O$, is called potassium (aquo) zincate, then these new compounds must receive the respective names, monopotassium ammonoargentate, monopotassium ammonobarate, monopotassium ammonostrontiumate or strontianate, monopotassium ammonocalciumate or calcate, dipotassium ammonolithiumate (or possibly lithianate) and dipotassium ammonosodiumate (or sodate or natronate). This procedure is of course pushing analogy to the limit and it may be that these products are not salts at all, but are molecular compounds as represented by the formulas

$$AgNH_2 \cdot KNH_2,\ Ba(NH_2)_2 \cdot 2KNH_2,\ NaNH_2 \cdot 2KNH_2,$$

etc., whatever the significance of such formulas may be. The writer hopes, by transference meas-

urements, to be fortunate enough to determine whether or not such a substance as $NaNK_2 \cdot 2NH_3$, for example, in solution in liquid ammonia dissociates into NaN anions and K cations, though it may well turn out that such experiments will show no results because of ammonolytic decomposition of the salt, for certainly if acid at all sodium amide must be a very weak one.

(2) *The Action of Potassium Amide on Cadmium, Nickel and Chromium Salts in Liquid Ammonia Solution.* By E. C. Franklin and George S. Bohart. Experience in this laboratory has shown that metallic amides, imides or nitrides are precipitated when a liquid ammonia solution of the ammono base, potassium amide, is added to similar solutions of the salts of heavy metals. It has also been found when the precipitant is added in excess that, in many cases, compounds are formed which are related to ammonia as the zincates and aluminates are related to water. (Cf. preceding abstract.) Following the procedure thus indicated the amides of cadmium and nickel, $Cd(NH_2)_2$ and $Ni(NH_2)_2$, have been prepared, both of which may be deammonated and thus converted into the corresponding nitrides, Cd_3N_2 and Ni_3N_2. It has also been shown that compounds of the second class indicated above are formed when potassium amide is added in excess to solutions of the sulfocyanates of cadmium, nickel and chromium. The products obtained have the composition represented by the empirical formulas, $CdN_4H_6K_2$, $Ni_3N_9H_{18}K_5$ and $Cr_2N_8H_{15}K_3$. Some light is thrown upon the nature of these compounds if they are formulated as follows:

$$Cd(NHK)_2 \cdot 2NH_3, \text{ or } Cd(NH_2)_2 \cdot 2KNH_2,$$

$$K_2NNi—NK—NiNK_2 \cdot 6NH_3$$

or

$$2Ni(NH_2)_2 \cdot 5KNH_2,$$

and

$$KN = Cr—NK—Cr = NK \cdot 5NH_3$$

or

$$(NH_2)_2Cr—NH—Cr(NH_2) \cdot 3KNH_2.$$

They may receive the respective names; potassium ammonocadmiate (or cadmate), potassium ammononickelate and potassium ammonochromate. When potassium nickel cyanide is treated with potassium amide one of the three complex compounds of the respective formulas,

$$Ni_3N_2H_2K_4(CN)_6 \cdot 8NH_3$$

(which loses ammonia to form $Ni_3N_2H_2K_4(CN)6_2$), $NiNHK_2(CN)_2$ and $Ni_3N_{11}H_{22}K_7(CN)_3$, is formed depending upon the relative quantities of the nickel salt and potassium amide used. We are unable to assign rational formulas to these compounds. Formulation as follows, however, furnishes some clue to their nature.

(1) $K_2(CN)_2Ni—NH—Ni—NH—Ni(CN)_2 \cdot K_2 \cdot 8NH_3$

or

$$K_4Ni(CN)_4 \cdot 6NH_3 \cdot 2Ni(NH_2)_2.$$

(2) $K(CN)_2NiNHK$

or

$$K_2Ni(CN)_4 \cdot Ni(NHK)_2.$$

(3) $(CN)Ni—NK—Ni—NK—Ni(CN) \cdot 5KNH_2 \cdot 4NH_3$.

Number 1 is a mixed potassium nickel cyanide-nickel amide or imide. Number 2 is a mixed potassium nickel cyanide-potassium ammononickelate, as is also number 3.

Gas Analyses by Liquefaction and Fractionatives and the Condition of Natural Gas in the Earth's Strata: G. A. Burrell and Frank M. Seibert.

The exact composition of natural gas such as is used in Pittsburgh, Pa., Cincinnati, Ohio, and many other cities is shown for the first time. As a result of this work it is shown that these gases are accumulated in their deposits in the gaseous condition, and not as liquids. If present therein as liquids it would be possible for single small subterranean reservoirs to hold much larger quantities of gas than they now do.

The Condition of Natural Gas in the Earth's Strata: G. A. Burrell and Frank M. Seibert. (Lantern.)

Collisional and Diffusional Viscosities: Eugene C. Bingham.

Heat and Chemical Energy of Molecules, Atoms and Subatoms: J. E. Siebel.

Electrostenolysis: Harry N. Holmes.

By electrostenolysis is meant the deposition of a metal or its oxide in very fine capillaries when the solution filling these capillaries is electrolyzed. Braun and Coehn experimented only with cracks in glass tubes. The author improved this method by the use of capillary membranes in the form of glass tubes packed with finely powdered substances such as glass, sulfur and silica. This multiplies greatly the capillary surfaces and permits the use of many different membranes. Working with tubes so prepared, the author added a number of examples of electrostenolysis to the list recorded by Braun.

Charles L. Parsons,
Secretary

(*To be concluded*)

／SCIENCE

FRIDAY, JULY 24, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MODERN VIEWS ON THE CONSTITUTION OF THE ATOM

AT a meeting of the Royal Society of Canada held at Montreal, May, 1914, the writer gave by request a summary of recent work and ideas on the nature of the atom. The object was to concentrate, as clearly as possible, but not exhaustively, the results and opinions scattered through many different publications. Few men have time or opportunity to collect and analyze for themselves the large output bearing on this fascinating subject.

1. It may be well to call attention to the general bearing of the situation. Biologists are divided into three camps, vitalists, mechanists, and those who sit on the boundary fence. The mechanists believe that all phenomena relating to life are attributed to the action of physical and chemical processes only. The vitalists believe that life involves something beyond and behind these. Now those who investigate natural philosophy, or physics, are endeavoring with some fair initial success, to explain all physical and chemical processes in terms of positive electrons, negative electrons, and of the effects produced by these in the ether, or space devoid of matter.

If both the mechanists are right, and also the physicists, then such phenomena as heredity and memory and intelligence, and our ideas of morality and religion, and all sorts of complicated affairs are explainable in terms of positive and negative electrons and ether. All of these speculations are really outside the domain of science, at least at present.

2. It has been remarked by Poincaré that each fresh discovery in physics adds

a new load on the atom. The conditions which the atoms have to explain may indeed be written down, but to do so is merely to make a complete index for all books on physics and chemistry in the widest sense.

3. In the early days of the kinetic theory of gases, now well established in its broad outlines, it was sufficient to regard the atom as a perfectly elastic sphere, and it is about a generation ago[1] that leading savants were triumphantly determining the effective radius as about 10^{-8} cm. (a convenient shorthand for the hundred millionth of a centimeter).

The discovery of electrons as the cathode rays of an electric discharge in an exhausted tube, and as the beta rays of radium, opened up new regions.[2] It appears that negative electricity consists of electrons with their accompanying but unexplained effects in the ether. Electrons in motion produce magnetic fields. Their effective mass is about one eighteen hundredth part of that of a hydrogen atom, and their effective radius one hundred thousandth. The greatest known speed of electrons nearly approaches that of light.

The Zeeman effect, or separation of a single line in the spectrum by suitable magnetic fields, into two or more lines proved conclusively that the vibrations of negative electrons in the atom are the cause of the disturbances in the ether which we know as light.

4. The first scheme of an electronic atom, propounded by Sir Joseph Thomson, was a sphere of positive electricity, of undefined character within which revolved concentric rings of electrons in the same plane. There necessarily followed the simplicity of circular motion under a force to the center, proportional to the distance between the electron and the center of the atom.

5. Previous to this Lord Rayleigh had called attention to a serious anomaly. In a train of waves of a periodic character, the electric intensity E varies as the sine of nt, where t is the time and $2\pi/n$ is the period. As the equations involve the second differential of E, it appears inevitable that the square of n should appear in the law for spectral series. As a matter of fact there appears not the square of n, but n itself. It is desirable to be more explicit. If parallel light from a luminous source passes through a slit and a prism, together with suitable lenses, then the eye or photographic plate can detect a number of bright lines forming the spectral images of the slit for different colors, provided that the light is from luminous mercury vapor or hydrogen, or some such source. Many of these lines have been found to belong to one or more series crowding together towards the violet end. Balmer and Rydberg have found that the general type of formula for their frequency n is

$$n = N_0\left(\frac{1}{a^2} - \frac{1}{b^2}\right),$$

where N_0 is a universal constant called Rydberg's number, the same in value for *all* electrons of *all* atoms; and a and b are whole numbers or integers. We shall refer later to the importance of Rydberg's constant and of this magnificent generalization.

The trouble to which Rayleigh referred was first faced by Ritz in a startling manner. He imagined that there were inside the atom, placed end to end, a number of small magnets with an electron constrained to move in a circular path around the line of magnets. With this hypothesis he was

[1] Young proved this in 1805, but his work was forgotten, until Rayleigh called attention to it in 1890 (*Phil. Mag.*, XXX., 474).

[2] It is remarkable how little the general public has shared in this advance. In Montreal there were eleven thousand people witnessing a wrestling match while few availed themselves of an invitation to meetings and discussions of the Royal Society.

able to account correctly for the above law for series of lines in the spectrum.

We may appreciate Poincaré's criticism—

On a quelque peine à accepter cette conception, qui a je ne sais quoi d'artificiel.

Inasmuch as physicists endeavor to explain magnetism in terms of revolving electrons, there is a lack of simplicity, and there is an inconsistency, in introducing elemental magnets inside the atom. Nevertheless, it must be admitted that Weiss has found remarkable evidence for the conception of *magnetons* or elemental unit magnets, producing intra-molecular fields reaching to millions of Gauss units, far transcending any produced by our most powerful electromagnets, and difficult to explain by revolving electrons.

Again to quote Poincaré—

Qu' est-ce maintenant qu'un magnéton? Est-ce quelque chose de simple? Non, si l'on ne veut pas renoncer à l'hypothèse des courants particulaires d'Ampère; un magnéton est alors un tourbillon d'électrons, et voila notre atome qui complique de plus en plus.

Perhaps the hypothesis of Bohr, explained later, may overcome the difficulty, but for some time to come the more prudent will suspend judgment on the magneton.

Recently there has been nothing short of a revolution in physics. In certain domains, the leading workers and thinkers have deliberately abandoned the classical dynamics and electro-dynamics, and made suppositions which are in direct opposition to these. This startling change may perhaps be justified by the fact that the famous laws and equations were based on large scale experiments, so that they do not necessarily apply to conditions within the atom. Those who put forward and make use of the new hypotheses, men like Planck and Lorentz, Poincaré and Jeans and others, appear to do so with reluctance, like a retiring army forced from one position to another. Others, like Rayleigh and Larmer, appear to regard the whole movement with misgivings, and some endeavor, like Walker and Callendar, to find a way out. There is a young school who go joyfully forward, selecting and suggesting somewhat wild hypotheses, and yet attaining an unexpected measure of success by their apparently reckless methods.

The main phenomena to which the new mechanics have been applied are the radiation within an enclosure, and the distribution of energy therein; the high speed of electrons ejected from matter by ultraviolet light, or by Röntgen rays, or by the gamma or penetrating rays from radioactive substances, or as I suggest that we call them, from *radiants;* the atomic heat of elements, so admirably handled by Debye; the residual energy at low temperatures; and the constitution of the atom.

Space prevents us from considering more than the last of these.

The first step towards the new method was taken by Planck when he saw the necessity of explaining why the energy of short wave radiation is some hundred millionth part of that demanded by classical dynamics. He made the supposition that energy is not indefinitely divisible, but he did not assume that it was atomic. He actually imagined that energy was emitted from oscillators in exact multiples of hn, where n is the frequency of the oscillation and h is a universal constant (Planck's) with a value 6.5×10^{-27} erg second. The magnitude of the energy quantum is thus proportional to the frequency.

This quantum hypothesis has spread like fire during a drought. It pervades the scientific journals. No physicist has pretended to explain or understand it, for, as Jeans says, the lucky guess has not yet been made. Nevertheless, it appears that "h" has truth underlying it, and that it

has come to stay, for the applications of the quantum hypothesis have already achieved a great and unexpected measure of success. In the meantime it is necessary to proceed with caution, checking every theory by experiment, for there is no other criterion to guide the investigator, whether to hold to the old or try the new.

7. The first steps towards the idea of the modern or Rutherfordian atom rest on an experimental basis, and are not, therefore, open to suspicion.

Rutherford and Geiger found that when the alpha particles from a radiant, such as radium or polonium, met a thin gold leaf, the bulk of the alpha particles passed through with slight deflection, but about one in eight thousand bounced back, or returned towards the side of their source. Both large and small deviations of the alpha particles in passing through matter were satisfactorily explained by ordinary or Newtonian dynamics, with the law of repulsion inversely as the square of the distance between similar electric charges. One charged particle was the alpha particle with a positive charge twice as large, numerically, as that of an electron. The other charged particle was the *nucleus* of the atom of gold, and the magnitude of this charge was about $\frac{1}{2}A$ where A is the atomic weight of gold. This view was subjected to a searching series of experimental tests and emerged triumphant.

8. About this time C. T. R. Wilson skilfully obtained photographs of the mist-ladened, charged air molecules, marking the track of a recent alpha particle, in an expansion chamber. Some of these photographs showed where a collision had occurred between the alpha particle and one of the heavier molecules of air. It immediately occurred to Sir Ernest Rutherford that a collision between an alpha particle and a lighter atom, such as hydrogen, would result in the nucleus of the latter being projected beyond the known range of the alpha particle. The point was put to the test by Marsden, and a complete justification of Rutherford's nucleus resulted. The hydrogen nuclei were found to produce scintillations on a zinc sulphide screen at a range about *four times as great* as that of the alpha particles. Some mathematical investigations by G. C. Darwin indicated that the alpha particle or nucleus of helium, and the hydrogen nucleus must have approached so close that their centers were but 1.7×10^{-13} cm. apart. This affords further evidence of the extreme minuteness of the nucleus compared with the size of an atom (10^{-8} cm.).

9. It may be well to recall at this point an interesting result of Barkla, obtained some years earlier, who showed from the scattering of Röntgen rays that the number of electrons in the atom must be about $\frac{1}{2}A$, where A is the atomic weight. In the case of an uncharged atom, the positive charge on the nucleus must evidently balance the negative charges on the electrons revolving in orbits around that nucleus.

Thus we can form a clear mental picture of the general character of the atom. It is a miniature solar system. The sun is replaced by the positively charged nucleus. The planets, perhaps confined to one or more definite orbits or rings, are replaced by negative electrons revolving rapidly around the nucleus. The gravitational force is replaced by the electrical attraction between the positive nucleus and negative electrons.

10. A brilliant young Dane, Bohr, has gone a step farther and suggested the structure of an atom capable of explaining the series of spectral lines. His work is remarkable as leading to excellent numerical verification. He assumes the Rutherfordian nucleus of electronic charge about half the

atomic weight; he assumes that for every revolving electron in every atom the angular momentum is constant. To be concise, he supposes that for each electron mass $\times$ velocity $\times$ radius $=$ Planck's constant $/2\pi$.

He further supposes that in a steady stationary orbit even a single electron does not radiate away energy. *This is entirely contrary to classical electrodynamics.* Furthermore he imagines that in passing from one state of stationary orbit to the next possible, there is homogeneous radiation of amount hn, where n is the frequency. This is of course Planck's assumption, and it is certainly unexplained, and probably not in accord with Hamilton's equations as deduced from Newton's laws. Nevertheless, any day we may learn why energy is emitted *per saltum,* and this mystery will vanish.

Now if you permit these somewhat arbitrary assumptions to Bohr, he can and does deduce, at least for the lighter atoms such as hydrogen and helium, the Rydberg formula for the spectral series. He finds:

$$n=\frac{2\pi^2me^4}{h^3}\left(\frac{1}{a^2}-\frac{1}{b^2}\right),$$

where n is the frequency; m, e, mass and charge of an electron; h is Planck's constant; a, b, are integers. The quantity before the bracket should equal the Rydberg number N_0, of observed value 3.29×10^{15}. Bohr's calculated value is 3.26×10^{15}, showing a most satisfactory agreement.

Bohr endeavors to account for the manner in which two hydrogen atoms form a molecule. Each atom has a nucleus of positive charge and a simple electron revolving around it. Their charges are equal and opposite. The nuclei of two such atoms repel each other. The revolving electrons of two atoms close together, if rotating in the same direction, constitute two parallel currents of electricity, and these attract one another and arrive in the same plane. It is easy to make a model on a whirling table with the nuclei on an upright rod, the electrons revolving like the governor balls of an engine. Bohr has gone further, and conceived a similar model of a water molecule with the two nuclei of hydrogen and one nucleus of oxygen in a straight line, with 10 electrons revolving in their zones around them. No doubt these suggestive schemes are somewhat speculative, but it is refreshing to find a first approximation to a dynamical scheme replacing the old unsatisfactory electrostatic atoms, which probably did not approximate to the truth. Some of the formidable organic molecules must have a complexity which it may take generations of physicists to unravel.

11. One of the triumphs of mathematical physics was the forecast of Laue that crystal bodies have their atoms so distributed that Röntgen rays must be diffracted by these atoms in the same manner that closely ruled crossed lines diffract visible light. This forecast and its rapid verification, enable the two Braggs, father and son, to measure with accuracy the wave-lengths of Röntgen rays. While the waves of visible light are of the order 10^{-5} cm., those of Röntgen rays are of the order 10^{-8} cm., about one thousandth of the former. The electromagnetic theory recognizes no intrinsic difference between the great waves of wireless telegraphy, several kilometers in length (10^6 cm.), short electric waves, long heat waves, visible light (10^{-5} cm.), ultraviolet waves, and Röntgen rays (10^{-8} cm.).

The method of reflecting Röntgen rays from a rock-salt or another crystal has been applied by Moseley with marked success to the determination of the nucleus charges of the atoms of most of the elements. He bombarded the elements one after the other, by electrons as cathode rays, reflected

the resulting Röntgen rays from a crystal and measured the wave-lengths of one or other of the principal (K or L, hard or soft) radiations.

In this manner he found

$$n = A(N - B)^2,$$

where n is the frequency of vibration, N the nucleus electronic charge, necessarily a whole number, and A and B are determined constants. In this manner he has found the *atomic numbers* N of all the known elements from aluminium 13 to gold 79. There appear to be but two or three elements not yet found by the chemists. These experimental results bear out well a view first propounded by van den Broek, that each element has an atomic number, an integer representing its place in the periodic table (H 1, He 2, Li 3, Be 4, Bo 5, C 6, and so forth). The atomic weight is not an exact integer, nor of such fundamental character as the atomic number. There will be further reference to this point later.

12. Rutherford has extended Moseley's method and results to the crystal reflection of the gamma rays from a radiant (Ra B), and determined the wave-lengths of many lines, in particular of the two strongest. He has bombarded lead with Ra B rays and found the wave-lengths of the radiation stimulated in the lead. He found that *Radium B and lead gave the same spectrum,* indicating that they have the same atomic number, 82. Hence he deduced the atomic numbers of all the radiants in the uranium-radium family. His results are worth repeating.

Radiant	Rays	Atomic Number	Atomic Weight About
Uranium 1	α	92	238.5
Uranium X 1	β	90	234.5
Uranium X 2	β	91	234.5
Uranium 2	α	92	234.5
Ionium	α	90	230.5
Radium	α	88	226.5
Radium Em.	α	86	222.5
Radium *A*	α	84	218.5
Radium *B*	β	82	214.5
Radium *C*	α, β	83	214.5
Radium *D*	β	82	210.5
Radium *E*	β	83	210.5
Radium *F*	α	84	210.5
Lead		82	206.5 (207.1)

13. All of these results are in harmony with the wonderful advances in radiochemistry due to Soddy, Fajans, Von Hevesy and others. It has been found that when a radiant emits an alpha particle or helium nucleus, the chemical properties of the newly formed radiant differ from the old. A fresh element is formed, a different valency results, and the new radiant, relative to the old, is *two* columns to the *left* in the periodic table. The atomic number has decreased 2, and the atomic weight about 4. But when a radiant ejects a *beta* particle or electron, again there is a new radiant with different valency and chemical properties, but there is a move of *one* column to the *right* in the periodic table; a gain of one in the atomic number and no change in the atomic weight.

A brief example of the whole scheme applicable to all radiants is given below:

Column			
IV.	V.	VI.	At. Wts.
Ur X 1 → 90, β	Ur X 2 → 91, β	Ur 2 92, α	234.5
		Ur 1 92, α	238.5

In the case of these radiants Ur 1 ejects an α particle and gives rise to Ur X 1. The latter and Ur X 2, respectively, emit a β particle.

It should be added that the short-lived product Ur X 2 or "brevium" was discovered by this theory, after it had been formulated from the known behavior of other radiants.

It will be seen that Uranium 1 and 2 are

in the same column and have the same atomic *number*, but that their atomic *weights* differ by 4. Such substances have chemical properties so identical that they are called inseparables, or non-separables, or isotopes, for they occupy the *same* place in the periodic table. Thus the old trouble of finding places in the periodic table for the thirty or forty radiant elements has suddenly vanished. They may be superposed even when their atomic *weights* differ, if their atomic *numbers* are the same. The nuclear charges of isotopes must be identical, but the distribution of electrons may be different. Other examples of inseparables are:

Lead, radium B, Radium D, all 82.
Thorium and radiothorium.
Radium and mesothorium.

If these views are distasteful to chemists let them discover some means of the separation of the known isotopes.

It must be further noted that the results of radiochemistry appear to require the presence of negative electrons in the nucleus itself. The expulsion of a β particle, or one negative electron, from the nucleus is equivalent to the gain of one positive electron, and involves a unit increase in the atomic number.

14. The last advance is the most important and far-reaching. There has been long search for the positive electron, and in vain; yet it seems likely that it has been under our eyes all the time. Since the hydrogen atom never loses more than a single electron, is it not possible, suggests Rutherford, that the nucleus of the hydrogen atom may be the positive electron?

The electro-magnetic mass of an electron is $\frac{2}{3}\frac{a}{e^2}$ where e is the charge and a the radius. If the mass of the hydrogen nucleus is wholly electro-magnetic, then its radius must be smaller than that of the electron (negative) as 1:1800, for that is the ratio of their masses, while their charges are equal and opposite. Hence we have

	Mass	Diameter
Atom	1	10^{-8} cm.
Negative electron	1/1800	10^{-13}
Positive electron	1	10^{-16}

Rutherford cautiously remarks that there is no experimental evidence against such a supposition.

Those who wish to follow the matter deeper must refer to many articles in the *Philosophical Magazine*,[3] several letters to *Nature*, Soddy's "Chemistry of the Radio-elements," part II., and Perrin's "Les Atomes." The chief writers have been Rutherford, W. H. Bragg, W. L. Bragg, G. C. Darwin, Moseley, Broek, Bohr, Russell, Fajans, Soddy, Hevesy, Nicholson and Mardsen.

Much has yet to be done, and much to be revised, but that the first great forward strides have been taken in the right direction there can be little doubt.

A. S. EVE

McGILL UNIVERSITY,
May, 1914

STATISTICS OF CROPS

DEGREE OF ACCURACY OF THE REPORTS OF THE BUREAU OF STATISTICS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

IN the March 28, 1913, number of SCIENCE, Dr. C. G. Hopkins gives a discussion of this topic under the title of "Facts and Fiction about Crops." The Department of Agriculture is accused of "condemnable inflation of crop statistics." The writer does not believe that such a conclusion would be reached if the reports were more carefully studied.

He shows the percentage of error to be very great when the Bureau of Statistics estimates of corn in the southern states are compared with the census report. If the error is due to wilful deception, we should expect to find the

same over-statement in the important corn states.

The largest error is in the case of Louisiana, where the Bureau of Statistics report of corn is 97 per cent. above the census report for 1909, being an error of 25 million bushels, but the crop of Iowa was underestimated by 52 million bushels. The corn crop of the United States was overestimated by 9 per cent. But a careful study of the methods of enumeration makes this error less conclusive. By the census method of enumeration, corn grown for silage is unfortunately put with coarse forage crops. It ought to be enumerated separately. There were over four million acres of such crops, of which corn certainly made up the larger part. By the methods used by the Bureau of Statistics, much silage corn is doubtless included with other corn. It is probable that this would reduce the error to 5 or 6 per cent.

A study of Table I. shows that of the thirteen crops reported, the production was underestimated on six crops, overestimated on six crops and practically correct on one crop. Of the six most important American crops, three, hay, cotton and potatoes are underestimated, oats were correctly estimated, while only two, corn and wheat were overestimated. Certainly there is no indication of wilful exaggeration. The most serious error is in the underestimate of the hay crop. Census reports include salt-marsh hay and all wild hay. It is probable that many crop reporters do not consider any of this as hay except that portion that is used for stock food. But even making an allowance for this difference, it is certain that the Bureau of Statistics reports are too low.

Careful study of Table I. and of the reports for individual states indicate that the errors in individual states may be very large, but

TABLE I

COMPARISON OF CENSUS AND YEAR-BOOK REPORTS OF CROPS IN THE UNITED STATES IN 1909[1]

Yields of grain are given in bushels, hay in tons, cotton in bales, tobacco and hops in pounds.

	Acreage			Production			Yield Per Acre		
	Census Report	Year-Book	Per Cent. Error	Census Report	Year-book	Per Cent. Error	Census Report	Year-book	Per Cent. Error
Corn	98,382,665	108,771,000	11	2,552,189,630	2,772,376,000	9	25.9	25.5	−2
Wheat	44,262,592	46,723,000	6	683,379,259	737,189,000	8	15.4	15.8	3
Oats	35,159,441	33,204,000	−6	1,007,142,980	1,007,353,000	0	28.6	30.3	6
Barley	7,698,706	7,011,000	−9	173,344,212	170,284,000	−2	22.5	24.3	8
Rye	2,195,561	2,006,000	−9	29,520,457	32,239,000	9	13.4	16.1	20
Buckwheat	878,048	834,000	−5	14,849,332	17,438,000	17	16.9	20.9	24
Potatoes	3,668,855	3,525,000	−4	389,194,965	376,537,000	−3	106.1	106.8	1
Hay and forage	72,280,776	——		97,453,735	——		1.35	—	
Hay	62,784,663[2]	45,744,000		80,302,526[2]	64,938,000		1.28[4]	1.42	
Cotton	32,043,838	30,938,000	−3	10,649,268	10,004,949	−6	0.33	0.32	−3
Tobacco	1,294,911	1,180,000	−9	1,055,764,806	949,357,000	−10	815.3	803.3	−1
Flaxseed	2,083,142	2,742,000	32	19,512,765	25,856,000	33	9.4	9.4	0
Rice	610,175	720,000	18	21,838,580	24,368,000	12	35.8	33.8	−6
Hops	44,693			40,718,748	36,000,000	−12	911.1		

[1] Year-book reports are from the Year-book of the United States Department of Agriculture for 1909 except the acreage of cotton, which is as reported in the 1910 Year-book. The production of cotton is the estimate as reported by the Bureau of the Census in the 1910 Year-book.

[2] The Census report for grasses, clover and alfalfa. These figures may not be exactly comparable with hay as reported by the Bureau of Statistics.

that the results for the United States are accurate enough to be very useful.

The percentage error is most likely to be high in states that grow little of the crop. The same is true of census reports. The error is also likely to be large in regions that are making the largest change in the area or yield of the crop.

The errors are the result of cumulative

errors. It is unfortunate that the Bureau did not adjust its figures to the census basis in 1899. This has been done since 1909 so that we may expect a much smaller error in the future as the error will be corrected at each census year. each year to be corrected so that the error from year to year would not be cumulative.

ARE OUR CROP YIELDS DECREASING?

In the same issue Dr. Hopkins discusses the question of crop yields. The conclusion

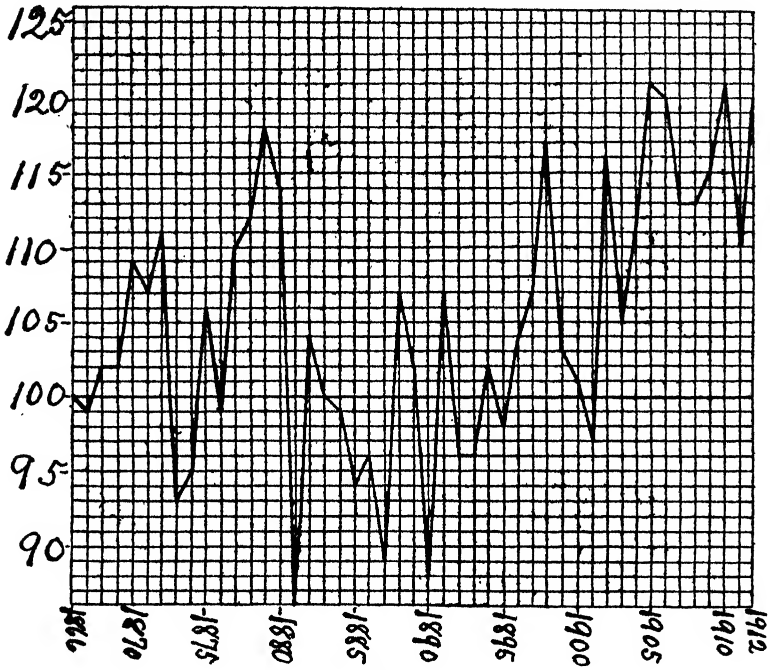

FIG. 1.

Comparative crop yields for the United States east of the Mississippi River. Yield of 1866 considered as 100 per cent.

The writer believes that the accuracy of the reports could be greatly increased if there were added to the present method of reporting a system of reports by farmers on actual areas grown and yields received. If the Bureau of the Census could send a large number of letters to farmers each winter asking for the area of the farms, area of each crop grown and total yield, these reports could be compared with reports from the same farms for previous years. The changes in areas of farms, failures of some men to report and other problems involved, would not, in the writer's opinion, be at all insurmountable. This information would allow the final report for

is reached that for the ten years 1899 to 1909, "*An increase of 15.4 per cent. in farmed land with an increase of only 1.7 per cent. in production reveals the truth of reduced yield per acre.*"

This conclusion is based on serious errors in the use of statistics. The production used is the total bushels of cereals. The acreage used is the area of improved land in farms. This land is not all farmed, much less is it all planted to cereals.

The census report states that

Improved land includes all land regularly tilled or mowed, land pastured and cropped in rotation, land lying fallow, land in gardens, orchards, vine-

yards and nurseries, and land occupied by farm buildings.

TABLE II

States East of the Mississippi River

					ats, Bu.	age, ns	Cott Bal	Potat Bu.
New England	1879	28.0	34.5	15.5	32.7	0.96		109
	1889	29.7	38.6	19.1	30.7	1.09		85
	1899	34.5	39.4	18.0	35.9	1.13		130
	1909	36.2	45.3	23.5	32.9	1.23		177
Middle Atlantic..	1879	23.4	33.1	14.1	28.5	1.10		95
	1889	24.1	32.8	16.7	27.4	1.29		70
	1899	25.3	34.0	14.9	30.9	1.19		95
	1909	24.6	32.2	18.6	25.5	1.32		107
East North Central..	1879	27.8	34.6	16.8	31.8	1.17		
	1889	29.1	34.3	15.7	34.5	1.30		91
	1899	31.5	38.3	12.9	37.4	1.22		85
	1909	32.7	38.6	17.2	33.3	1.38		101
South Atlantic..	1879	11.8	13.3	8.8	9.9	0.84	0.35	—
	1889	12.5	13.7	10.3	10.8	1.09	0.35	70
	1899	13.0	14.1	9.5	11.7	1.02 –	0.39	77
	1909	15.1	15.8	11.9	15.5	1.02 +	0.45	92
East South Central..	1879	15.9	19.1	7.7	10.3	0.82	0.39 –	
	1889	18.1	20.7	10.6	12.1	1.06	0.35	81
	1899	16.1	18.4	9.0	11.1	1.03 +	0.39 +	63
	1909	17.5	18.6	11.7	13.4	1.03	0.32	82

States West of the Mississippi River

West North Central..	1879	26.8	37.4	10.6	28.9	1.32		—
	1889	29.1	36.4	13.2	30.9	1.26		90
	1899	24.8	31.4	12.2	32.0	1.34		95
	1909	23.1	27.7	14.9	27.5	1.33		92
West South Central..	1879	13.4	14.0	6.6	17.0	0.82	0.47	
	1889	20.0	20.9	10.6	20.2	1.35	0.41	73
	1899	20.6	21.9	11.9	25.8	1.48	0.39	67
	1909	15.9	15.7	11.0	21.4	1.03	0.27	63
Mountain.	1879	21.1	16.6	18.8	28.9	1.13		—
	1889	21.3	14.4	20.0	27.8	1.36		69
	1899	22.4	16.5	19.2	30.4	1.59		113
	1909	26.5	15.8	23.1	34.9	1.73		143
Pacific.	1879	18.6	27.1	16.3	30.5	1.45		—
	1889	17.3	30.2	15.0	28.4	1.49		95
	1899	18.7	25.2	15.6	31.4	1.44		129
	1909	21.7	24.0	17.7	35.3	1.73		[illegible]

United States

1879	22.7	28.1	13.0	25.3	1.15	0.40	
1889	25.1	29.4	13.9	28.6	1.26	0.37	84
1899	24.0	28.1	12.5	31.9	1.28	0.39	93
1909	23.6	25.9	15.4	28.6	1.35	0.33	106

If the area of cereals bore a constant ratio to all improved land, the final conclusion might have been correct in spite of the error in method used, but this is far from the case. Other crops have increased much more rapidly than cereals. The area of cereals increased 3.5 per cent., and other crops increased 22 per cent., in ten years.

The truth is that the area of cereals harvested increased 3.5 per cent. (not 15.4 per cent.) while the bushels of cereals increased 1.7 per cent.

Another serious error involved is in the use of figures for the entire United States. A large amount of arid land in the Dakotas, Nebraska, Kansas, Oklahoma and Texas that was not farmed in 1899 is now planted to crops and lowers the average yields for the entire country.

Nor is it safe to use total bushels of cereals as a measure of production. The normal yields of oats and wheat in bushels are not the same and the proportion of land planted to each is very far from constant.

In order to study the question, we must deal with the individual crops grown in some particular region. The accompanying table gives such a comparison with the states grouped by the method used in the last census. The production of cereals in bushels and averages for the United States are included for comparison with the article by Hopkins, although the writer does not consider either of these figures safe ones to use, for reasons given above. The yield of hay and forage shows a decided increase, but again this is made up of a number of crops whose normal yields are different, so that a shift in kind of crop changes the yield.

In the states east of the Mississippi River, comparatively little new land has been added to farms in the last twenty years. For this reason these states are the ones that give the best information as to changes in crop yields.

The highest yield of cereals ever reported by the census for New England, the East North Central, and South Atlantic, states is the crop of 1909. In the Middle Atlantic states, the highest yield ever reported is for 1899 with

1909 second. In the East South Central states 1889 is first with 1909 second.

The Corn Crop.—The highest yield per acre of corn reported by the census for Illinois, Indiana, Ohio, is for 1909. The total for all states east of the Mississippi River gives 1909 as the highest yield, but in some of the groups of states there have been better yields. The fact of a lower yield for the entire country in 1909 is not, therefore, as is commonly stated, due to a decrease in yields in the older states.

Wheat.—The highest yield of wheat reported in any census year is for the year 1909, with an average of 15.4 bushels. The nearest competition was the year 1889, when the yield was 14 bushels. The year 1909 is the best year ever reported in each of the groups of states except in the West South Central.

Oats.—In the New England, Middle Atlantic and East North Central states, the best oat yield reported by the census is for 1899. For the southern states east of the Mississippi, the best year reported was 1909.

Hay and Forage.—The highest yield per acre of hay and forage ever reported is for the year 1909. As stated above, this figure should not be given too much weight, because shifts in acreage of the different kinds of crops in this collective group might affect the result.

Potatoes.—The highest yield per acre of potatoes ever reported by the census is the last report. This is true for each of the groups of states east of the Mississippi River. The only groups that show a decrease are the West North Central and West South Central.

Cotton.—The old South Atlantic states reported by far their best cotton crop for the year 1909. The best report from the East South central states is for 1899. The cotton yield per acre for the entire United States was lower in 1909 than in any other census year, but this is in spite of high yields in the old Atlantic states. The area of cotton in the United States increased nearly one third in the ten years. This increase was mostly due to extending the crop on arid lands and on other lands that were considered too poor to farm ten years before. The West South Central states, where most of the new arid land has been added, have shown a steady decrease in yield. Oklahoma increased its area by 190 per cent., but production increased only 146 per cent. Low yields in Oklahoma should not be charged to soil exhaustion in Georgia. The poor results in Texas and some of the other neighboring states are also partly due to the boll weevil as well as to season and soil.

Considering the above five different regions east of the Mississippi River and the six important crops, corn, wheat, oats, hay and forage, cotton and potatoes, we find the following:

Number of instances of first rank in crop yield:

1879	*1889*	*1899*	*1909*
0	3	5	19

These figures show very strikingly the general increase in crops in later years in these older states.

For the West North Central and West South Central groups, there is only one instance in which the 1909 yield is the best. In these states there appears to be a general decrease in production. This difference is primarily due to the bringing in of arid land that was not formerly used. The Mountain and Pacific states show a general increase in yields.

REPORTS BY THE BUREAU OF STATISTICS

A better method of comparing crop yields is on the basis of the reports by the Bureau of Statistics because these yields are secured for every year. The amount of rainfall in any particular year makes the figure for a single year inconclusive.

As has been previously shown, the Bureau of Statistics estimates the yields of the important crops with a fair degree of accuracy. The yield per acre of corn for 1909 was estimated at 2 per cent. less than the census results. The yield per acre of wheat was 2 per cent., oats were 6 per cent. and potatoes 1 per cent. higher than census returns.

Fig. 1 shows the comparative yields of corn, wheat, oats, barley, rye, buckwheat, potatoes and hay in states east of the Mississippi

River based on the 1866 yield as 100 per cent. The comparative yields of each crop, considering the 1866 crop as 100 per cent., were calculated. These percentages were weighted according to the area planted to the crop in order to secure a percentage representing the yield of that year.

G. F. Warren
Cornell University

STANFORD UNIVERSITY MEDICAL SCHOOL

Dr. Victor C. Vaughan, dean of the department of medicine and surgery of the University of Michigan, has made, under date of June 9, 1914, the following report to Dr. J. C. Branner, president of Leland Stanford Junior University:

In compliance with your telegraphic request I have visited Palo Alto and San Francisco and inspected the libraries, laboratories and hospitals of Stanford University. The laboratories of chemistry (general, physical, inorganic, organic and physiological), biology, histology, neurology and physiology are well housed, adequately equipped and exceptionally well manned. In all these, high grade work is being done. The laboratories of bacteriology and anatomy need better housing and I understand that this is to be provided in the near future. But in the buildings now occupied, most excellent work is being done. In fact each of the scientific departments at Stanford is under the direction of an eminent man supplied with able and enthusiastic assistants and with necessary equipment. There is abundant evidence even in a hasty inspection that the appropriations have been economically and wisely expended and that good work is being done both in instruction and in research. I wish to compliment the trustees and president upon the evident wisdom which they have displayed in the development of these departments of the university. What I have said of the scientific branches is equally true of the other departments of Stanford University. Although one of the youngest of the higher institutions of learning in this country Stanford ranks as one of the best in all departments, both scientific and humanistic. In all branches it represents the highest aims and ideals. While I am not fitted to express anything more than a general opinion as to other than scientific education I wish to emphasize the fact that all learning is one and the same spirit should pervade the whole. This I believe to be true at Stanford. It furnishes a wholesome atmosphere in which the student can grow whatever special line of training he may follow later. The greatest need of our country is the man whose fundamental knowledge is broad and comprehensive and whose special training is exact. No man can have useful knowledge of a part unless he has general knowledge of the whole. The working of the part must be in harmony with the movements of the whole; otherwise disaster is the result. While I am especially interested in medical education, I recognize the fact that it is futile to try to develop a good medical man out of one whose fundamental training has not been sound. The young man who has learned to work with the right spirit, whether it be in Greek or biology, in philosophy or chemistry, will enter medicine, law or any profession in the right frame of mind and will be likely to prove an honor in his chosen profession. In his preliminary college training the prospective medical student should not be confined to the physical or biological sciences. It is desirable that he know the classics, history and philosophy and it is most desirable that the training that he gets along these lines should be of the highest grade. I believe that Stanford University furnishes suitable conditions for the development of the young man who is going into medicine. Therefore I hope that the medical work done at Palo Alto may continue. If the medical school should be closed, this would relieve Stanford of only one of the laboratories at Palo Alto. Physics, chemistry, biology, physiology, histology, embryology, neurology and bacteriology must be taught and research work in these branches must be done in a university of the high rank Stanford holds. Closing the medical school would give only trifling financial relief to the university. I therefore recommend that the premedical and medical work now done at Palo Alto be not only continued but be developed as fast as the finances of the university permit. I make this recommendation not only for the good of the medical school, but, as I believe, in the interest of the university as a whole. If the medical department should be discontinued, anatomy is the only subject which could be dropped at Palo Alto and even then this should not be done. Anatomy is one of the great and fundamental biological sciences and even human anatomy should be taught in a great scientific university. Anatomy is no longer taught as a mere foundation for medicine and surgery. It includes the development of structure from the lowest to the highest forms of life.

I went to San Francisco and made an inspection of the library, hospital and laboratories of the medical school.

The Lane library is one of the best medical libraries in the country. It is supplied with practically all the best medical journals so arranged as to be most available to members of the faculty and students. Its location in regard to the hospital and laboratories is quite ideal. It is worth much to both the clinical and the research man to have at his hand the best contributions of the world. When a problem comes up for solution the first thing to learn is to ascertain what has already been done along this line. A medical school without a library is like a boat without a pilot and much time is likely to be lost in drifting. The medical department of Stanford is fortunate in the possessing of its library.

While the present hospital building is somewhat out of date it is, so far as I can see, admirably managed both in caring for the sick and in the instruction of students. The out-patient department, systematized as it is, is both a great, broad and needful charity and at the same time a source of varied and comprehensive instruction to students. The addition soon to be made to the hospital will modernize the institution. It will bring more pay patients to the institution and thus furnish the funds with which the less fortunate can be cared for. I was greatly pleased with the management of the hospital. The laboratories in the hospital are ably conducted and fairly well equipped. Some of them will probably have enlarged and improved quarters when the addition is made to the hospital.

As I understand the total cost of the medical department is now about one hundred thousand dollars per year. This cost will slowly increase. Notwithstanding this fact I strongly urge that the medical school be not only continued but be developed. In its development the quality of its work should be constantly held in mind. The number of medical students should be kept small. Quality and not quantity should be the aim. I believe that in the near future the medical department will be a source of strength to the university in many ways. First, in the importance of the research done and the benefits that such research will confer on the race. Within the past thirty years the average human life has been increased nearly fifteen years and the whole of life has been made more comfortable. This is a work to which a great university should contribute. The opening of the Panama Canal will bring to the Pacific coast many health problems which can be best solved in such a school of instruction and research as I believe Stanford will develop. Second, I am firm in the belief that the medical school will attract large donations, both for research and the clinical work. Philanthropists will see that the best service they can render lies in the direction of improved health conditions. Third, medicine is now attracting to its ranks many of the best of our young men and this will be a source of strength to the university.

Lastly, I come to the matter on account of which I was called to visit you. The time may come when it may be wise to consolidate the two university medical schools of San Francisco, but I do not believe that this would be wise at present. Stanford, from what I can learn, can afford to develop its medical school without material hindrance in the growth of other branches and I believe that this is the wise thing to do.

I am aware of the fact that a hasty visit, such as I have made, may give erroneous impressions and I would not have you attach any great importance to this report, but I have tried to look at matters from a broad viewpoint and to hold constantly in mind the good of Stanford University as a whole. I have considered it unnecessary to go into financial or other details with which you are much more familiar than I am.

In conclusion I wish to thank you, . . . and Dr. Wilbur and other members of your faculty for the many courtesies shown me and to express the hope that the growth of Stanford University during the past quarter of a century, phenomenal as it has been, may be surpassed in its future developments.

With great respect, I am

Yours most respectfully,

V. C. VAUGHAN

NEWTON HORACE WINCHELL

THE tribute I can render to the late Professor Winchell must be such as would quite spontaneously come from any one who had watched, with appreciation and sympathy, the progress of geological science in America during the past generation. I can not speak of Professor Winchell from a close personal intimacy, but I may, as one of many who highly regarded his very unusual achievements in one science and his broad, effective interest in sev-

eral others, express the esteem of his colleagues for the record he has left.

The science of geology renders high service to her followers in return for services rendered to her; she carries them far afield and opens up to them the guiding influences of all activities which have to do with the earth. If "an undevout astronomer is mad," even so is an uninspired or narrow-minded geologist. I am sure every geologist of long and loving contact with the earth feels that he is "the freeman," the real proprietor of "the varied fields of nature"; "the mountains, and the valleys and the resplendent rivers" are "by an emphasis of interest his." They are a heritage into which the acolyte but gradually comes, for the devotees of this science must render first an implicit and exclusive service to her elementary factors before they can venture far from her leading strings. They must first be "mere computers and measurers" to whom the science is no more than "chemical analyses, calculations of times and distances, labeling of species," men who "are seeking scientific knowledge for its proximate values" until such time as they grow into "an increasing consciousness of its ultimate value in the transfiguration of things."

In looking over the accounts which have been given in tributes already rendered to Professor Winchell's career, there stands out with perfect clarity the fact of his undivided devotion to geology through long years, when once he had found his measure, and the climax of this service was the execution from inception to end of the *Geological and Natural History Survey of Minnesota;* but even this finely rounded work was but a stepping stone to broader human relations.

Professor Winchell, like his distinguished elder brother Alexander, Professor Orton, Major Powell, O. C. Marsh, Israel C. Russell, all geologists of great eminence, was a child of New York. The venerable Geological Survey of New York would like to feel that it had had some influence in giving direction to the notable careers of these men. It may have been so in a measure, though perhaps least of all in Professor Winchell's case, for the hard scrabble farm on the sadly confused rocks in the town of North East, Dutchess county, where he was born and passed his childhood, may hardly have developed such a tendency toward an after lifework, no matter how much the constraints of a sterile soil might contribute to sturdy robustness of physique and character.

It has been said that Professor Winchell's performance in the execution of the Minnesota Survey has not been equalled in the history of American geology. The act providing for this comprehensive service was not drawn by him or enacted for him, but upon its passage in 1872 he was called from Ann Arbor and put in charge of the work. The organization that began with him ended in him, and, in view of its scope, his record is unique.

The plan of this undertaking, says Dr. Folwell, who as president of the University of Minnesota drew the bill and secured its enactment, was to have the work carried on by the members of the university faculty and this was done for a while, Professor Winchell holding the double position at the head of the survey and of the department of geology, but the increasing duties of the former compelled an eventual divorce of the two. For twenty-eight years without interruption he carried forward this scientific survey of a commonwealth covering eighty thousand square miles of territory and when the work was done or "the survey closed," as it is rather unhappily said, the information acquired and the problems discussed and the potentialities indicated had been presented to the world in a series of twenty-four annual reports, ten bulletins and six imposing quartos. It is distinctly to the credit of Winchell that he was never really succeeded in office. His state regarded his duty discharged and his work well done; but it did not stand so much to the credit of Minnesota that it could regard a geological survey as ever "closed."

The selection of Professor Winchell for a work of such importance to his state shows by its event, the wise insight of those who had the hopes of the organization in their keeping. There were still "geologists" in those days;

none are left now. The "all round" man competent to advance with equal foot along the many divergent lines of this comprehensive science, exists no longer. The "State Geologist" now may know one route expertly, others less well and some not at all, but with a capacity for good generalship he can yet perform the functions of his office without a masquerade. Professor Winchell was a sturdy, honest geologist with an extraordinary capacity for work and a reliable judgment in organization. He was more than that: his real interests in the science were very broad and he himself entered many fields. His first interest was in the chemistry of the rocks, their mineralogy and origin. He wrote on every phase of geological industry, from mining to water supply and agriculture; on Archean geology with an extensive personal acquaintance; intimately on optical mineralogy and petrography; somewhat profusely on the succession and significance of glacial phenomena; the complicated and sadly mistreated Taconic question he discussed with eminent fairness, and the sheaf of his reviews in the *American Geologist* indicates the still wider reach of his interests. That he desired to share in all departments of his organization is evinced by his titular co-authorship with Professor Schuchert in treatises on paleontology for his final reports, a field into which he would hardly have ventured alone.

The exploitation of all these fields was the legitimate duty of his organization and he led the way into all. And in addition to these services he did not ignore the fact that he was carrying on a "Natural History" as well as a Geological Survey, as several of its bulletins indicate. There will be no more such geological surveys in this country, into all of whose parts the chief can enter with skill and reasonable finality, and this fact makes the performance of Winchell one of which he was indisputably the author, and the great storehouse of the data he assembled in the best years of his labor is a monument of distinction to him and to the state which authorized it.

Professor Winchell's later interest as state geologist had been among the events of the ice age and the postglacial waters. These investigations, of high worth and broad concern, easily led him into a field with many pitfalls: primitive anthropology. He traversed this field with care and came out into much safer ground: the culture of the aborigines. This latter study absorbed the attention of the years after his survey had closed, and in 1911, under the auspices of the Minnesota Historical Society, he published a quarto of over 700 pages on the "Aborigines of Minnesota."

We can not attempt to analyze more closely here Professor Winchell's publications. They were numerous and varied but they do not by any means show forth his full service to science. He was the promoter, founder and chief editor of the *American Geologist*, a monthly journal whose annual financial deficit in the service he personally bore for the eighteen years of its existence. It was a catholic and helpful exponent of the science and there are many who still regret the transmigration of its soul.

At the last annual dinner of the Geological Society of America, Professor Winchell gave an explicit account of the organization of that society in which he played a prime part as proposer and founder, and his interest was acknowledged by his election to its presidency a few years after the organization was effected. He was one of the founders of the Minnesota Academy of Science and thrice its president, and a member of a number of scientific, historical and archeological societies.

It would be interesting to find the real clue to Professor Winchell's intellectual inclinations and singleness of purpose. Looking both forward and back from his personality, there seems an almost obvious "continuity of the germ-plasm" marked partly by his extraordinary presentation to his science of three distinguished devotees: his sons, Dr. Horace V. Winchell, Professor Alexander N. Winchell, and his son-in-law, Dr. Ulysses S. Grant. Some part of his impulses must have come from his tutelage and association with his brother, Alexander Winchell, at Ann Arbor, where he received his first sure direction into paths that led him for periods of service into

the geological surveys of Michigan and Ohio. It would indeed be worth while to know if the germs which impelled this noble pair of brothers into the same paths may really not have been picked up on the old home farm in Dutchess county, N. Y. Supervening all these early influences and regulating all their impulses, there was in the home, as is well known to many American geologists, a wise and gentle adviser in all the enterprises of his manhood, the unseen hand that kept the harp in tune.

John M. Clarke

SCIENTIFIC NOTES AND NEWS

Dr. Ira Remsen, ex-president of the Johns Hopkins University; Dr. L. H. Bailey, formerly director of the State College of Agriculture of Cornell University; Professor T. C. Chamberlin, of the University of Chicago; Professor Edwin G. Conklin, of Princeton University; Professor William M. Wheeler, of Harvard University, and Dr. Charles D. Davenport, director of the station of experimental evolution of the Carnegie Institution, planned to sail from San Francisco on the steamer *Tahiti* on July 22, to attend the Australasian meeting of the British Association for the Advancement of Science as guests of the New Zealand government.

Officers of the American Ornithologists' Union elected for the coming year are as follows: Albert K. Fisher, *president;* Henry W. Henshaw and Witmer Stone, *vice-presidents;* John H. Sage, *secretary;* Jonathan Dwight, Jr., *treasurer;* Ruthven Deane, William Dutcher, Frederic A. Lucas, Wilfred H. Osgood, Chas. W. Richmond, Thos. S. Roberts, and Joseph Grinnell, members of the council.

Dr. George H. Whipple, associate professor of pathology in Johns Hopkins Medical School, has been appointed director of the Hooper Institute, San Francisco.

Dr. Oscar Teague, of the Cornell University Medical School, has been appointed director of the new bacteriological laboratory of New York City at Quarantine.

The trustees of the Albert Kahn Travelling Fellowships have appointed Mr. Alan G. Ogilvie, of the School of Geography, Oxford University, a fellow of the British Foundation for 1914–15.

Captain J. F. Parry has been appointed to succeed Rear-Admiral Herbert E. P. Cust, C.B., as hydrographer of the British navy.

The University of Liverpool has conferred on Dr. T. F. Wall, lecturer on electrical engineering at the University of Birmingham, the degree of doctor of engineering.

Dr. Lemoine, professor of clinical medicine at Lille, on the occasion of the twenty-fifth anniversary of his teaching was presented with a picture of himself, painted by M. Pharaon de Winter.

The Mackinnon studentship of the Royal Society on the biological side has been awarded to Mr. G. Matthai, of Emmanuel College, Cambridge, for a research on the comparative anatomy of the Madreporaria.

The Emile Chr. Hansen prize for 1914 has been awarded to Professor Jules Bordet, director of the Institut Pasteur of Brabant.

The committee has awarded the Alvarenga Prize of $180 to Dr. Herman B. Sheffield, of New York, for his essay entitled "Idiocy and the Allied Mental Deficiencies in Infancy and Early Childhood."

The American Anthropologist states that the Cayuga County Historical Society of Auburn, New York, conferred the "Cornplanter Medal for Iroquois Research" on Mr. J. N. B. Hewitt of the Bureau of American Ethnology, Washington, D. C., for his work in the field of Iroquois anthropological study. The Cornplanter medal was founded in 1901 largely through the efforts of Professor Frederick Starr, of the University of Chicago, and a number of his friends who aided in providing the necessary means. The administration of the Cornplanter medal for Iroquois Research was then undertaken by the Cayuga County Historical Society. Four classes of workers are eligible to receive it, namely: (*a*) Ethnologists making worthy field-study or other inves-

tigations of the Iroquois; (*b*) Historians making actual contributions to our knowledge of the Iroquois; (*c*) Artists worthily representing Iroquois life or types by brush or chisel; (*d*) Philanthropists whose efforts are based on adequate scientific study and appreciation of Iroquois needs and conditions. Those who have previously received the award of the medal are, in their order, General John S. Clark, of Auburn, N. Y.; Rev. William M. Beauchamp, of Syracuse, N. Y.; Dr. David Boyle, of Toronto, Canada; Hon. William P. Letchworth, and Reuben Gold Thwaites.

Mr. H. R. Schmitt, of the Carnegie Department of Terrestrial Magnetism, completed successfully, early in July, a magnetic exploratory trip across Chile and Bolivia, from the Pacific coast to Corumba, Brazil.

Dr. Lew Chee, Peking, is visiting the United States, to inspect hospitals for information to be used in the construction and management of a hospital to be built in Canton next year at a cost of $750,000.

Father Cortie is arranging an eclipse expedition to Hernösand. The party will consist of Father Cortie, Father O'Connor, Mr. J. J. Atkinson and Mr. G. J. Gibbs.

Mr. C. Boden Kloss is engaged in an expedition, with Mr. H. C. Robinson, director of museums, Federated Malay States, to Mount Indrapura or Korinchi in Central Sumatra—a volcano 12,700 feet high and the highest summit in the island. The objects of the expedition are zoological and botanical, but it is hoped to ascend to the summit of the mountain and make observations of the crater and the present activity of the volcano.

In noting the election of M. Lacroix to the permanent secretary of the Paris Academy of Sciences in the issue of Science for July 10, his Christian name should have been given as Alfred.

The tenth session of the Congrès Préhistorique de France will be held at Aurillac (Cantal), from August 23 to 29, under the presidency of M. Pagès-Allary.

The Canadian government has decided that the new observatory to contain the six-foot reflecting telescope is to be situated on Little Saanich Mountain, near Victoria, British Columbia.

A conference of observers and students of meteorology and allied subjects is to be held in Edinburgh from September 8 to 12.

The non-magnetic yacht, *Carnegie*, under the command of J. L. Ault, arrived at Hammerfest, Norway, on July 3, twenty-five days out from Brooklyn. Magnetic and electric observations were secured on the entire trip. The results agree well with those obtained on the *Carnegie* in 1909.

The Robert Koch Foundation offers a prize of $750 for the best article on "The Importance of the Various Forms of Radiation (Sunlight, Roentgen Ray, Radium and Mesothorium) for the Diagnosis and Treatment of Tuberculosis." The articles, which must be in German, must be in the hands of the secretary of the foundation, Professor Schwalbe, not later than July 1, 1915.

The list of civil list pensions granted by the British government during the year ended March 31 last includes, according to *Nature*, the following grants for scientific services: Mr. A. J. M. Bell, in recognition of his valuable contribution to geology and paleontology, £60; Mrs. Traquair, in consideration of the services to science of her husband, the late Dr. R. H. Traquair, F.R.S., and of her own artistic work, £50; Mrs. Gray, in recognition of the valuable contributions to the science of anthropology made by her husband, the late Mr. John Gray, £50; Mrs. Wallace, in consideration of the eminent services to science of her husband, the late Dr. Alfred Russel Wallace, O.M., F.R.S., £120; Mrs. Alcock, in recognition of the valuable contributions to the study of physiology made by her husband, the late Professor N. H. Alcock, £50; Mrs. Ward, in recognition of the eminent services of her husband, the late Professor Marshall Ward, F.R.S., to botanical science, £40; Dr. Oliver Heaviside, F.R.S., in recognition of the importance of his researches in the theory of high-speed telegraphy and long-distance telephony, in addition to his existing pension, £100; Miss

Hearder, in consideration of the contributions to electrical science and telegraphy of her late father, Dr. J. N. Hearder, £70; Miss Willoughby, in consideration of the services of her late father, Dr. E. F. Willoughby, in connection with questions of public health, £30.

THE third biennial meeting of the New England Federation of Natural History Societies was held at the Glen House, White Mountains, during the first week in July. Delegates from a dozen of the federated societies joined in a survey of the flora and fauna about timber line on the Presidential Range. Among those present were C. W. Johnson, curator of the Boston Society of Natural History (diptera), W. T. M. Forbes, of Worcester (lepidoptera); J. H. Emerton, secretary of the federation (arachnidæ); John Ritchie, Jr., president (mollusca), and E. B. Chamberlain, New York; Tracy Hazen, Barnard College; M. A. Chrysler, Orono, and others in the different groups of botany. Mr. Johnson reports the taking of much interesting material which serves to corroborate and define the work of the earliest botanists and W. S. Hunt, of Lynn, visited the station for Sibbaldia and reported on it.

THE joint meeting of the Vermont Botanical Club and Vermont Bird Club was held during the second week in July at Fairhaven, Vt., the two presidents, Dr. Ezra Brainerd, of Middlebury, and Professor G. H. Perkins, of Burlington, being in attendance. The former led the botanical trips and the latter cared for the other interests. About twenty-five were present, covering the length and breadth of the state. Collections were made in the cedar swamp at Fairhaven, which yielded a number of rare species of plants and on the cliffs overlooking the Poultney River in West Haven, places that have been little visited by botanists. President Brainerd announced that the check list of the plants of Vermont, prepared by the club, will shortly be published by the experiment station at Burlington. The company received the courtesies of the board of trade of Fairhaven, which furnished transportation to the distant portions of West Haven and thus greatly aided the collectors.

A REPORT by Edson S. Bastin on the producduction of graphite in 1913, just issued by the U. S. Geological Survey, describes the properties, uses and origin of graphite, records the production and imports in 1913, and describes the mode of occurrence at most localities where it has been quarried in the United States and at foreign localities which contribute to our domestic consumption. The island of Ceylon is the world's greatest graphite-producing center and the United States absorbs about one half of its product. Other countries that contribute graphite to our industries are Korea, Madagascar and northern Mexico. These large drafts on foreign sources, amounting in 1913 to 28,879 short tons, valued at $2,109,791 are in marked contrast to the small domestic production of natural graphite, which in 1913 was only 4,775 tons, valued at $293,756. As it has been fully demonstrated that natural graphite occurs in our own country in practically inexhaustible quantities, the question arises, Why should our industries be so dependent on foreign supplies? The reason lies in the mechanical difficulty in concentrating the American product. Most of the graphite found in this country occurs in small flakes in banded rocks known as schists. The graphite forms only 5 to 10 per cent. by weight of the rock, and the crushing of the rock and clean separation of the graphite flakes have proved commercially successful only in a few favored places. A number of new methods are now being tried which it is hoped will prove more efficient—notably the electrostatic process that has been applied with so much success to the treatment of zinc ores. The shortcomings of the United States in the production of natural graphite are in part atoned for by the large amounts of graphite produced in the electric furnaces at Niagara Falls. From its commercial inception in 1897 the industry of manufacturing graphite has grown rapidly until in 1913 the output was valued at nearly a million dollars. The various grades of manufactured graphite are adapted to practically all the uses to which graphite has been applied except crucible-making.

UNIVERSITY AND EDUCATIONAL NEWS

AN additional gift of $60,000 for dormitories at Cornell University is announced from the anonymous donor who gave the original $100,000.

AN anonymous donor has made a gift of £10,000 to the general endowment of the Royal Technical College, Glasgow, on condition that another sum of £15,000 is promised within a year.

THE Johns Hopkins Hospital is preparing to celebrate the twenty-fifth anniversary of its opening next October. The celebration will begin on October 5, with a meeting at which Dr. William H. Welch will preside and Sir William Osler, of Oxford University, will speak. On October 7 the new Brady Urological Institute will be dedicated.

WITH the registration for the summer session at Columbia University practically complete, there are 5,625 students; the largest number, by more than a thousand. It is the thirteenth year of the session, and with the exception of the years 1903–06, when the number remained at about 1,000, the increase in numbers has been by larger percentages each year. Last year the attendance was 4,530; the year before, 3,602; and 2,973 in 1911, while that of the first year, 1902, was 643.

THE trustees of the University of Pennsylvania have voted to admit women to the school of medicine of the university, beginning in the fall of 1914.

DR. HAROLD PENDER, professor of electrical engineering, Massachusetts Institute of Technology, and director of the research division of the department of electrical engineering, will become professor in charge of the department of electrical engineering at the University of Pennsylvania next fall.

DR. WALTER RAY BLOOR, of the medical school of Washington University, St. Louis, has been appointed assistant professor of biological chemistry in the Harvard Medical School.

IN the medical school of the University of Alabama Dr. William H. Clarke has been appointed professor of anatomy and Dr. J. Howard Agnew, formerly first assistant in the department of medicine of the University of Michigan, to a full-time professorship.

IN the medical department of the University of Louisville the following appointments are announced: Dr. Leon L. Solomon, professor of medicine and clinical medicine; Dr. David C. Morton, professor of clinical medicine; Dr. Sidney J. Meyers, professor of medicine and medical economics; Dr. Frank W. Fleischhaker, professor of physical diagnosis, and Dr. F. Stuart Graves, Boston, professor of pathology and bacteriology, vice Dr. Leon K. Baldauf, resigned.

THE following changes and promotions in the faculty of the Maryland Agricultural College and Experimental Station are announced: The organization of the extension and demonstration service, of which Professor T. B. Symons, of the School of Horticulture is appointed director. To this service the following transfers from the college and experiment station staff are made: Nickolas Schmitz, agronomist; W. T. L. Taliaferro, in charge of farm surveys and management; G. E. Wolcott, in charge of dairy extension; C. L. Opperman, poultryman, and Reuben Brigham. The Agricultural College is reorganized into divisions as follows: Division of agronomy and animal husbandry, W. T. L. Taliaferro, acting dean; division of applied science, H. B. McDonnell, dean; division of horticulture, T. B. Symons, dean; division of rural economics and sociology, F. B. Bomberger, dean, and division of engineering, T. H. Taliaferro, dean. Promotions in the faculty: R. N. Cory, associate professor of entomology to be professor of zoology; L. B. Broughton, associate professor in chemistry to be professor of analytical chemistry; Grover Kinzy, assistant professor of agronomy, to be associate professor of agronomy and farm machinery.

AT the University of Birmingham, according to *Nature*, Dr. J. S. Anderson has been appointed assistant lecturer and demonstrator in physics for one year in succession to Dr. Fournier d'Albe. Mr. W. Hulse has been appointed demonstrator in mining in succession to Mr. Clubb. Mr. Gilbert Johnson has received a research position in the zoological department.

DISCUSSION AND CORRESPONDENCE

NOTES ON THE FOSSIL VERTEBRATES COLLECTED ON THE COPE EXPEDITION TO THE JUDITH RIVER AND COW ISLAND BEDS, MONTANA, IN 1876[1]

As I was Professor E. D. Cope's assistant on the above expedition, and as such diverse opinions are held regarding the stratigraphy of this Montana district, I have thought it of interest to try and disentangle the muddle, and to show that the Montana beds are to be correlated with those of Red Deer River, Alberta, on the evidence of their vertebrate fossils.

The following list gives the species collected by us in 1876, and described by Professor Cope, in camp on Dog Creek, four miles east of Judith River. I mention only the specimens I remembered positively, and collected (or handled), from the top of the "bad-lands" on Dog Creek. We were camped on the narrow flood plain, and every morning at daybreak we mounted our horses and climbed to the top of the strata, where our real work began. We passed over what Cope called the Pierre and Fox hills groups of Dr. Hayden, to the latter's typical locality, from which he secured the material described by Dr. Leidy, viz., of *Trachodon, Deinodon, Trionyx,* etc. We secured many specimens of these types, and many Cope described as new to science. Among them are the following: *Myledaphus bipartitus* Cope, *Hedronchus sternbergi* Cope, *Trionyx foveatus* Leidy, *Trionyx vagans* Cope, *Compsemys imbricarius* Cope, *Compsemys victus* Leidy, *Compsemys obscurus* Leidy, *Deinodon horridus* Leidy, *Deinodon (Aublysodon) lateralis* Cope, *Deinodon hayzenianus* Cope, *Deinodon (Lælaps) incrassatus* Cope, *Palæoscincus costatus* Leidy, *Dysganus encaustus* Cope, *Dysganus haydenianus* Cope, *Dysganus bicarinatus* Cope, *Dysganus peiganus* Cope, *Trachodon mirabilis* Leidy, *Diclonius pentagonus* Cope, *Diclonius perangulatus* Cope and *Diclonius calamarius* Cope.

We then followed the prairie forty miles down to Cow Island, and went into camp three miles below the landing on the opposite (south) side of the Missouri River. Here no teeth, fragments of bones nor turtle shells were found on the surface, as on Dog Creek.

It was possible to locate the bones in one way only, viz., by noticing the color of the surface dust above the bones, which in all cases differed from that of the surrounding disintegrated rock. By digging beyond the action of the frost we found the following species of Cope—*Monoclonius crassus, Monoclonius spenocerus, Monoclonius recurvicornis* and *fissus.* The *Monoclonius crassus* was found by Cope, at least the type; Mr. Isaac also got a *crassus.* Cope's specimen was found on the south side of the river in the hills about three miles below Cow Island. My specimens of which I got *recurvicornis* and *spenocerus* came from the north side of the river about four miles below Cow Island Landing, and Mr. Isaac's a mile farther down on the same side of the river, both near the flood plain.

I had the pleasure last year, and the year before, of exploring the Edmonton and Belly River series of Red Deer River, Alberta, and to me the succession of the rocks appears to be the same as in Montana, from the mouth of the Judith River to Cow Island.

At Dog Creek are the typical Judith River beds of Hayden and Cope, followed below by the Fox-Hill-Pierre, which are in turn underlain by the Cow Island beds, the Judith River beds correlating with the Edmonton, and the Cow Island with the Belly River series.

In descending Red Deer River last June from Drumheller to Berry Creek, a distance of eighty miles, the Pierre beds were seen appearing from beneath the Edmonton, and the Belly River from beneath the Pierre.

The evidence of the fossils corroborates the distinction between the Cow Island beds and the Judith River beds at Dog Creek. The trachodonts of the Belly River formation, for instance, are quite distinct from those of the Judith River and Edmonton. Take, for example, *Gryposaurus notabilis* Lambe, with its short heavy skull, high quadrate and elevated nasal. Again the resemblance of the Belly

[1] Published with the permission of the Director of the Canadian Geological Survey.

River *Ceratopsia* to those of the Cow Island beds is marked. Lambe's *Centrosaurus apertus* is much like Cope's *Monoclonius crassus*. The skull of the great spiked dinosaur *Styracosaurus albertensis* Lambe, the most unique of the horned dinosaurs, appears to be related to Cope's *Monoclonius sphenocerus*. The Edmonton *Trachodon* secured from Macheche Creek six miles above Drumheller, on the Red Deer River, Alberta, is closely related to *Trachodon annectens* from the Lance formation.

CHARLES H. STERNBERG
GEOLOGICAL SURVEY OF CANADA

"HYDRAULICS" IN THE ENCYCLOPEDIA BRITANNICA

TO THE EDITOR OF SCIENCE: While examining the article "Hydraulics" in the eleventh edition of the Encyclopædia Britannica, Vol. 14, p. 35, I discovered three errors, one of which, at least, is worthy of note in SCIENCE, as it may cause some one to lose valuable time if the published figures are taken too seriously.

The first and most serious of these errors is the value of the coefficient of viscosity for water at 77° F. which is stated to be 0.00000191 in lbs. per sq. ft. per unit velocity gradient in feet per second.[1]

The correct equation for this value in C.G.S. units is

$$\text{Coefficient of viscosity} = \frac{0.0178}{1 + .0337t + .000221t^2}$$

t being in centigrade degrees.[2]

If the numerator be multiplied by the number of square centimeters in one foot and divided by the number of dynes in one pound while the value of t is replaced by $(t - 32) \times 5 \div 9$, the expression for the coefficient of viscosity will become

$$\textbf{Coefficient of viscosity for water} = \frac{0.0000372}{.4700 + .0144t + .000068t^2}$$

the units being the foot, pound and Fahrenheit degree.

If 77 be now substituted for t the result will be the value of the coefficient for water at 77° F., or, 0.0000188, which is nearly ten times the value given by the Encyclopædia Britannica.

[1] See p. 35, upper right-hand part.

[2] See p. 536, Lamb's "Hydrodynamics," 1906.

Another error occurs in the same article, p. 77, near the top, equation (4). The last sign in the right-hand member should be a minus sign instead of a plus sign. The correct equation is

$$H_1 = \sqrt{(2u_0^2H_0 \div g + \tfrac{1}{4}H_0^2)} - \tfrac{1}{2}H_0. \qquad (4)$$

In Fig. 168, p. 90, the curve marked "Exper. III." should be marked "Exper. I." and the curve marked "Exper. I." should be marked "Exper. III.," the numerals evidently being transposed.

The error in the coefficient of viscosity was carried forward from the ninth edition of the Encyclopædia Britannica and was noted by me in 1909 in a paper on backwater published in *The Minnesota Engineer*, University of Minnesota.

B. F. GROAT

SCIENTIFIC BOOKS

Principles of Stratigraphy. By AMADEUS W. GRABAU, S.M., S.D., Professor of Paleontology in Columbia University. New York, A. G. Seiler and Co. 1913. Pp. xxxii + 1185 + index, with numerous illustrations.

This is a monumental work, one which presents fully and systematically the newer viewpoints in the interpretation of the rocks as the record of geologic history. For this reason it will be of great value, especially to the younger generation of American geologists, in broadening their mental horizon and outlining the problems which rise for solution in the twentieth century study of the rocks. It differs from other manuals in the English language to such a degree that it supplements but does not supplant them. It contains a notably large incorporation of material from German sources and makes full use of recent critical literature of both foreign and American authors. Nearly all of the older geologic manuals, although valuable encyclopedias of geologic science, have stored up the proven knowledge of the past, but have not pointed out the fields for investigation. They have further emphasized facts and principles as explaining facts, rather than as criteria of interpretation. This work contains a wealth of facts, though differing quite largely from that assemblage which has been carried down

in English manuals; but it is in the presentation of the facts as a basis for the interpretation of the past that it shows a different point of view.

The author has made large use of physiographic data. In fact, many chapters could be used without change in a work on physiography. This the reviewer regards as an element of great strength in the book. Physiography, a younger member of the family of geological sciences, rests upon a stratigraphic and structural foundation. The present can not be understood without a knowledge of the past. On the other hand, the past can not be interpreted without an understanding of the present, but stratigraphers and students of historical geology have not learned as yet to make full use of physiographic principles. It is the purpose of an investigation which should determine the classification of the field of science rather than the facts which are used. Defined by this standard, physiography is that division of geology whose purpose is to explain the present; the purpose of stratigraphy and historical geology is to explain the past. But as both involve an understanding of past and present, no man can work to advantage in either field without a knowledge of both. For these reasons Grabau rightly regards the work of W. M. Davis as of great importance for the principles of stratigraphy.

The aim and scope of a volume are best shown by a statement of the conditions which developed its need and led to its production. Quotations from the author's preface will best give this view.

This book is written for the student and for the professional geologist. It aims to bring together those facts and principles which lie at the foundation of all our attempts to interpret the history of the earth from the records left in the rocks. Many of these facts have been the common heritage of the rising generation of geologists, but many more have been buried in the literature of the science, especially the works of foreign investigators, and so have generally escaped the attention of the student, though familiar to the specialist. Heretofore there has been no satisfactory comprehensive treatise on lithogenesis in the English language, and we have had to rely upon books in the foreign tongue for such summaries. It is the hope of the author that the present work may, in a measure, supply this need.

The book was begun more than fifteen years ago, and the material here incorporated has been collected and sifted during this interval. . . .

The "Einleitung in die Geologie als historische Wissenschaft" had appeared only a few years before, and its influence in shaping geologic thought, especially among the younger men, was just beginning to be felt. The "Lithogenesis der Gegenwart" presented such a wealth of facts concerning the origin of sedimentary rocks, that attention began to be diverted from the problems of the igneous rocks which had heretofore almost exclusively occupied petrographers, and "Sediment-Petrographie," or the petrography of the sedimentary rocks, attracted more and more of the younger geologists, especially in Germany and France. . . .

It was at this period, too, that the attention of geologists and especially stratigraphers was first seriously directed toward the desert regions of the world and the phenomena of extensive subaërial deposition. Here, again, Walther led the way in that classic, "Die Denudation in der Wüste," followed in 1900 by his epoch-making book, "Das Gesetz der Wüstenbildung," which, in its revised edition, appeared in 1912. It is, of course, true that important studies of the desert regions were made earlier, notably those of von Zittel on the Libyan desert (1883), but the significance of the desert deposits in terms of stratigraphy was first fully appreciated within the last decade. That the importance of the desert as a geological factor has become widely recognized is shown by the numerous recent studies, especially those on the Kalahari by Passarge, and those on the Asiatic deserts, by Sven Hedin, Pumpelly, Huntington and others.

It is during this decade that the sciences of glyptogenesis and geomorphology have come into being, notably through the labors of Davis in America, and of Suess and Penck in Europe. Suess's "Antlitz der Erde" began to appear, it is true, in 1883, but it is only in recent years that this work has been readily accessible to most American students, through the medium of the English translation by Sollas and Sollas (1904–1909). Penck's "Morphologie der Erdoberfläche" appeared in 1894, but did not become well known in this country until much later. It was, however, Davis's publications in this country, chiefly during the early nineties of the last century, which gave

the great impetus to the study of land forms, and especially of the influence of erosion on their production. The concept of the peneplain, of the cycle of erosion, of the sequential development of rivers and erosion forms on the coastal plain and on folded strata, and others chiefly due to him, have become of incalculable value to the stratigrapher. The more recent development of the idea of desert planation by Passarge and Davis has opened further promising fields to the stratigrapher, who seeks to interpret the record in the strata by the aid of modern results achieved by universal processes.

In the field of correlative stratigraphy the past decade has likewise seen striking advances. The publication of the "Lethæa" falls into this period, and so does Marr's comprehensive little volume, "The Principles of Stratigraphical Geology," not to mention the elaborate recent texts of Haug, Kayser and others, or the numerous publications of government surveys, and of individual contributors. That questions of correlation have reached an acute stage in American geology is manifested by such recent publications as the "Outlines of Geological History" and Ulrich's "Revision of the Paleozoic Systems," and the numerous papers accompanying or called forth by these. Finally, paleogeography, as a science, is of very recent development, most of the works of importance having appeared in the last five years. In America Schuchert and Bailey Willis are the acknowledged leaders, while in Europe many able minds have attacked the problems of paleogeography from all angles.

It is thus seen that this book was conceived during the period of initial reconstruction of our attitude toward the problems of geology, and that its birth and growth to maturity fell into that tumultous epoch when new ideas crowded in so fast that the task of mastering them became one of increasing magnitude and, finally, of almost hopeless complexity. To summarize and bring together the ideas of the past decade, and focus them upon the point of view here essayed, is probably beyond the power of one individual. Nevertheless, the attempt to present the essentials of the new geology for the benefit of those who, grown up with it, have perhaps treated it with the lack of consideration usually bestowed on a contemporary, as well as for those who will carry on the work during the next decade or two, can not but serve a useful purpose. May this attempt be adjudged not unworthy of its predecessors, nor unfit to stand by the side of its contemporaries.

Having given the author's point of view, there may be noted briefly the especial features of some of the chapters.

In Chapter II., on the atmosphere, in addition to a review of meteorological principles, there is an extensive treatment of wind erosion and transportation. Space is given also to the indications and nature of rhythmic climatic changes.

The hydrosphere is treated in the next three chapters. Under Morphology and Subdivisions of the Hydrosphere are considered the forms of oceans, lakes and rivers. The most pertinent assemblage of material of this section is, however, in that chapter dealing with the movements of the hydrosphere and their geological effects, especially in the transportation and shaping of material.

There follows in Chapter VI. a classification of the rocks of the earth's crust.

The heart of the volume is found, however, in ten chapters, IX. to XVIII., inclusive, which deal with the original structures and lithogenesis of the sedimentary rocks, and it is for this section of 417 pages, if the reviewer mistakes not, that the work will be regarded as most distinctively a contribution to geologic science. There is throughout an application from present sedimentation to ancient sediments, more especially to those of the Paleozoic. If this section be compared with those dealing with the nature of sedimentary rocks in the standard manuals of geology in the English language, it will be seen that not only is it many times more comprehensive and extensive, but that traditional, over simple, and conventional interpretations are retested by the appeal to nature. This section leads to the conclusion that a much larger part than has been the custom should be ascribed in earlier ages to eolian and fluviatile sedimentation and their climatic implications.

Chapters XIX. to XXIII., inclusive, give 164 pages to metamorphism, earth sculpture, igneous activity and diastrophism. Parts of these chapters are better and more fully treated in other works and are not clearly within the province of the book, but other

parts, such, for example, as that on subaquatic gliding of sediments, are novel, are well treated, and valuable for their bearings on the origin of certain structures and relations of stratified rocks.

The next section of 187 pages deals with the biosphere. There is given a classification of the organic kingdom and the relations of each group to its environment. The principles which control the geographic distribution of animals are also set forth.

A final section deals with the principles of classification and correlation of geologic formations.

One of the most valuable features of the volume consists of the bibliographies which are given at the end of each chapter and the frequent references to the more important papers on each subject. The work thus is a guide to the student for his independent navigation and exploration upon that ever-broadening and rising ocean of literature which threatens to drown research.

From this statement of contents it is seen that the work is a notable contribution. very geologist dealing with stratigraphic or geology should give it a place in that elect reference shelf, the revolving book case within reach of his office chair.

To prove that this eulogistic review is the result of a judicial study of the volume it is necessary, however, to supplement the previous stements by finding something for adverse at, even if only of minor importance. leal of space has been given to the of secondary structures—faults, folds, metamorphism, igneous intrusion, etc. This has added to the bulkiness and cost of the volume without adding proportionately to an increase in its value. This greater cost will tend to keep it on the reference shelves of libraries instead of installing it in the private library of every student. The book is consequently likely to have less influence than if the detailed discussion of secondary structures had been ruled out or published as a separate volume. The subject matter does not appear sufficiently essential for the principles of stratigraphy to require incorporation, and a comprehensive study of these fields requires furthermore the study of other treatises, such as those of J. Geikie, Van Hise and Leith.

Classification is necessary in order to deal with the subject-matter of science, and classification must grow with the growth of knowledge. One of the noteworthy features of the work is the development of systematic classification to cover the field of sedimentation and stratigraphy. It aids in a logical and precise treatment, but the reviewer thinks that the author may have partially hindered his purpose by an over-classification and the extensive coinage of unfamiliar Greek names. Such words as caustobioliths and sapropelcalcilyths are examples. The renaming of contact metamorphism as æthoballism and dynamic metamorphism as symphrattism seems unnecessary and is hardly likely to succeed. To discuss earthquakes under the division of the centrosphere seems also quite inappropriate. "The littoral" in its original meaning and as used by a number of geologists has been restricted to the zone of shore between high and low tide. The stratigraphic characters are unique in that they receive the impress of alternate exposure to the air and sea. This dual relation must be recognized in order to avoid the inherited confusion between continental and marine deposits. The reviewer regards it as unfortunate, therefore, to extend it as a general term as is here done to cover all that region from the high-tide line to the edge of the continental shelf. This in some regions is more than 100 miles from the shore and in ancient times was often vastly farther. On the other hand, however, it should be noted that the refinement of classification adds greatly to the analysis of the original structure and lithogenesis of the continental sediments, divided under the heads of atmoclastic, anemoclastic and hydroclastic rocks, assisting in a better presentation of these groups than has heretofore appeared.

An enumeration and discussion of the multiple hypotheses which may participate in complex processes is of great value to the advanced student, opening his mind to various possibilities and stimulating his imagination to

new research. Through most of the book this is very well done, but the causes of climatic change through geologic time do not find adequate treatment. There is, for instance, a rather extensive presentation and commendation of the several hypotheses of a wandering pole, but almost no discussion of the influence of changing atmospheric composition and none of such factors as a possible reversal of the oceanic circulation or possible changes in solar radiation. The absence of a dynamic proof of polar wandering adequate to account for climatic change makes it seem to the reviewer the least supported of all the climatic hypotheses.

To sum up this volume in a sentence—it is in the broad and admirable treatment of the present processes of sedimentation and in the interpretations which they give to the older sedimentary rocks that the book will be found to have its unique value.

JOSEPH BARRELL

Some Fundamental Problems in Chemistry. By E. A. LETTS. New York, D. Van Nostrand Co. 1914. 15 × 22 cm. Pp. v + 235. Price $2.50.

In the preface the author says that one of his "chief ideas was to contrast certain ancient views, such as those of atoms and a primordial element or primordial elements in the shape of air, earth, fire, and water, together with the possibility of transformations of these latter into each other, with the modern conception of electrons and the discovery of changes, such as those which the radioactive elements experience, which amount in fact to a change of one so-called chemical element into others. . . ." It is perhaps a question whether many readers will agree with the author that these two modern discoveries prove that even in science history may repeat itself; but fortunately one may like the book without accepting the author's thesis.

The book consists of four chapters on the older chemistry and seven on the newer chemistry. Under older chemistry the subheads are: ancient theories regarding the nature of matter and more recent theories as to the nature of energy; the atomic theory and atomic weights; the periodic law. There is nothing especially interesting or novel about this portion of the book and it might well have been omitted, thus giving the author an opportunity to amplify the portion on the newer chemistry, which is very interesting.

The newer chemistry, as understood by the author, deals with the effects of electrical discharges on gases in high vacua, radioactivity, Lockyer's theory of inorganic evolution, and Arrhenius's views on the birth and death of worlds. This part is admirable though distinctly not critical. The author apparently accepts, without much reservation, all the transmutations which Ramsay has described.

With Plücker tubes as a starting-point the author discusses the production of cathode rays when the degree of exhaustion is increased, and the properties of these rays. From cathode rays he passes to canal rays and thence to Röntgen rays. After that come Becquerel rays and then the discovery of radium by the Curies. The properties of the α, β, and γ rays are discussed and then the decomposition products of radium. The facts in regard to the production of helium are followed by an account of Ramsay's experiments on the alleged formation of lithium, carbon and neon. The author does not point out, as he well might have done, that it would be in the interest of science for Ramsay either to accept Mme. Curie's work on lithium or to repeat it and show wherein the discrepancy occurs. The present state of things is distinctly not creditable, and Ramsay's unwillingness to meet the situation raised by Mme. Curie's work on the alleged production of lithium has caused Ramsay's work on the alleged production of carbon and neon to be received with much suspicion. The last chapter on radioactivity deals with J. J. Thomson's discussion of the periodic law on the basis of the electron theory.

The chapter on inorganic evolution may be summed up as follows: In the very hottest stars we find hydrogen, helium, asterium and doubtless other gases, still unknown. At the next (lower) temperatures, we find these gases

becoming replaced by metals in the state in which they are observed in the laboratory, when the most powerful jar spark is employed. At a lower temperature, the gases disappear almost entirely, and the metals occur in the state produced by the electric arc. These changes are simply and sufficiently explained on the hypothesis of dissociation.

The final chapter on the birth and death of worlds is based on Arrhenius's book entitled "Worlds in the Making." Arrhenius takes up the questions of the creation and of the eventual destruction of the stars and of worlds like our own, and gives reasons for believing that both operations are simultaneously occurring in cosmos, or, so to speak, a "winding up" and a "running down" of the machinery of the universe; the two chief forces at work being the mechanical pressure of light, or simply the "radiation pressure," on the one hand, and gravitation on the other.

WILDER D. BANCROFT

PROPOSED INTERNATIONAL MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF AUGUST 21, 1914 (CIVIL DATE)

IN response to an appeal for simultaneous magnetic and allied observations during the coming total solar eclipse, cooperative work will be conducted at stations along the belt of totality in various countries and also at some outside stations.

The general scheme of work proposed by the Carnegie Department of Terrestrial Magnetism embraces the following:

1. Simultaneous magnetic observations of any or all of the elements according to the instruments at the observer's disposal, every minute from August 21, 1914, 10^h A.M. to 3^h P.M. Greenwich civil mean time, or from August 20, 22^h to August 21, 3^h Greenwich astronomical mean time.

(To insure the highest degree of accuracy, the observer should begin work early enough to have everything in complete readiness in proper time. See precautions taken in previous eclipse work as described in the journal *Terrestrial Magnetism*, Vol. V., page 146, and Vol. VII., page 16. *Past experience has shown it to be essential that the same observer make the readings throughout the entire interval.*)

2. At magnetic observatories, all necessary precautions should be taken to insure that the self-recording instruments will be in good operation not only during the proposed interval but also for some time before and after, and eye-readings should be taken in addition wherever it is possible and convenient. (*It is recommended that, in general, the magnetograph be run on the usual speed throughout the interval, and that, if a change in recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base line.*)

3. Atmospheric-electric observations should be made to the extent possible with the observer's equipment and personnel at his disposal.

4. Meteorological observations in accordance with the observer's equipment should be made at convenient periods (as short as possible) throughout the interval. It is suggested that, at least, temperature be read every fifth minute (directly after the magnetic reading for that minute).

5. Observers in the belt of totality are requested to take the magnetic reading every thirty seconds during the interval, 10 minutes before and 10 minutes after the time of totality, and to read temperature also every thirty seconds, between the magnetic readings.

It is hoped that full reports will be forwarded as soon as possible for publication in the journal of *Terrestrial Magnetism and Atmospheric Electricity*.

L. A. BAUER

WASHINGTON,
June 23, 1914

SPECIAL ARTICLES

AMMONIFYING POWER OF SOIL-INHABITING FUNGI

A COMPARATIVELY large amount of work has been done on the power of soil bacteria to produce ammonia from the nitrogenous materials found in the soil, or from organic materials such as dried blood or cotton seed meal added

to the soil. A comparatively small amount of work has been done on the power of soil-inhabiting fungi to produce ammonia under like conditions. Müntz and Coudon[1] demonstrated that the production of ammonia from the organic matter in soils is a property common both to molds and to bacteria. It is interesting to note that they used both bouillon and one hundred gram portions of soil, with manure added as culture media. In their investigations they used two pure cultures of molds, *Mucor racemosus* and *Fusarium Muentzii*. Later Marchal[2] confirmed their results.

In a series of investigations which were carried on for the purpose of determining the effect of acid phosphate on the ammonification of dried blood in soils, we observed that with varying percentages of acid phosphate the amount of ammonia accumulated in one particular type of soil increased with the increase of acid phosphate from 0.25 per cent. to 2 per cent. There was but a slight decrease of ammonia in the soil receiving 5 per cent. of acid phosphate. In fact, there was over one half more ammonia accumulated in the soil containing 5 per cent. of acid phosphate than in the soil to which no acid phosphate had been added. It was also observed that there was a very heavy growth of molds on all soil portions receiving acid phosphate. Counts were made of bacteria in the soil portions, and it was found that there was a decrease from 240,000,000 bacteria per gram of soil in the portions containing 0.5 per cent. of acid phosphate to 12,200,000 in the soil portions receiving 5 per cent. of acid phosphate. The opposite effect was noted in using certain other soils. There was no appreciable growth of molds in these soils, and the amount of ammonia accumulation decreased with increased quantities of acid phosphate. This was exactly the opposite of what was to be expected as several investigators have held that molds use ammonia for the development of their mycelium. From these results we were led to conclude that there was either a modification in the character or number of ammonifying bacteria present, or that it was due to the ammonifying power of the large number of fungi present in this soil and that this activity was stimulated by the addition of a large quantity of acid phosphate.

Several plates which showed a considerable number of mold colonies were set aside to allow further development. Various fungi were separated into pure cultures. Of these the commonest were *Zygorhynchus Vuilleminii, Rhizopus nigricans,* and certain species of *Penicillium*. To guard against possible contamination of the plates by spores from the air, these fungi were reinoculated into the soil from which they were isolated. Their growth in this medium determines their status as soil-inhabiting fungi. The fungi so secured include, in addition to those already named, species of *Alternaria, Aspergillus* and *Trichoderma* and several species of *Mucor*. One other species, *Monilia sitophila,* was isolated from soils, which had been heated to a high temperature in the autoclave.

As the decomposition of the nitrogenous materials in soils is influenced to a certain extent by their chemical and physical composition and by their reaction, two soil types were used; one of these was a gravelly loam acid soil, the other a red shale neutral soil. Identical methods were used in the ammonification studies. One hundred gram quantities of sterile soil were used. The "beaker method"[3] was employed. Dried blood and cotton seed meal were used as sources of nitrogen, amounts of these containing 155 mgs. of nitrogen were used in each case. The cultures were incubated at 30° C. for seven days, and the ammonia determined.

There was found to be a considerable difference in the power of the various soil fungi studied to ammonify dried blood and cotton seed meal in the soil; that is, in their ammonifying efficiency. A comparison of all of these fungi was made in the loam soil, using dried blood as a source of nitrogen. In all cases but one the addition of two grams of acid phosphate increased the ammonifying effici-

[1] *Compt. Rend. Acad. Sci.*, Paris, 116: 395. 1893.

[2] *Bull. Acad. Roy. Belgique*, III., 25: 727. 1893.

[3] N. J. Experiment Station Report, 1908: 129.

ency. It is interesting to note that with a single exception there was an increased growth of mycelium, with increased ammonia accumulation. In the case of *Zygorhynchus*, there was but a slight growth of mycelium, although a fairly large amount of ammonia was accumulated in the soil. Of the cultures studied, *Trichoderma* showed the largest ammonifying efficiency, which was 48.52 per cent. in soil not containing acid phosphate, and 58.39 per cent. in soil containing 2 per cent. of acid phosphate. On the other hand, *Penicillium I.* showed an ammonifying efficiency of 21.39 per cent. in soil containing no acid phosphate, and 16.45 per cent. in soil containing 2 per cent. of acid phosphate. *Penicillium VI.* showed a very low ammonifying efficiency, which was 10.75 per cent. without acid phosphate, and 12.15 per cent. with 2 per cent. acid phosphate added. A comparison was made of the ammonification of dried blood and cotton-seed meal in the two different soils, inoculating them with *Penicillium VII.* and *Rhizopus nigricans*. More ammonia was accumulated in each soil from cotton-seed meal than from dried blood in the case of both fungi.

The addition of calcium carbonate appeared to inhibit the ammonification of dried blood in the red shale soil with *Rhizopus* and *Penicillium VII.*, but the addition of even small amounts of acid phosphate increased the ammonia accumulation. From some of the results obtained, it appears that the presence of soluble phosphates in the soil, rather than its reaction, determines the amount of ammonia accumulation.

In comparing the ammonifying power of soil bacteria with that of soil fungi using dried blood in the loam soils, the highest amount of ammonia accumulated in the case of the bacteria was with *Bacillus subtilis*, which showed 54.13 milligrams of ammonia nitrogen in the portion not containing acid phosphate and 17.55 milligrams in the portion containing 2 per cent. acid phosphate. In the case of fungi, the highest amount of ammonia accumulated was by *Trichoderma* which showed 75.20 milligrams ammonia nitrogen in the portion not containing acid phosphate and 90.50 milligrams of ammonia nitrogen in the portion containing acid phosphate.

A more detailed account of these fungi and of the data accumulated by us concerning them will be published at an early date.

Harry C. McLean,
Guy West Wilson
N. J. Agricultural Experiment Station,
New Brunswick, N. J.

THE IOWA ACADEMY OF SCIENCE

The meetings of the twenty-eighth annual session of the Iowa Academy of Science were held at Iowa State Teachers College, Cedar Falls, beginning Friday afternoon, April 24, and closing at noon Saturday, the 25th. The meeting was called to order at 1:30 P.M. by the president, Professor C. N. Kinney, of Drake University. After the preliminary business was transacted the academy proceeded to the reading of papers until adjournment to meet at 9:00 A.M. Saturday.

The evening address was given by Dr. N. H. Winchell, of the Minnesota Historical Society, on "The Antiquity of Man in North America in Comparison with Europe."

Following the reading of papers and the final business meeting a luncheon was served in the gymnasium at noon, Saturday.

As officers for the ensuing year the following elections were made:

President, H. S. Conard, Grinnell.
First Vice-president, H. M. Kelly, Mount Vernon.
Second Vice-president, L. S. Ross, Des Moines.
Secretary, James H. Lees, Des Moines.
Treasurer, A. O. Thomas, Iowa City.

It was decided to try the plan at the next annual meeting, to be held at the State University of Iowa, Iowa City, of carrying out the program in two divisions: a general session and sectional meetings.

It was also recommended that the state legislature be urged to appropriate additional funds to enable the Geological Survey to complete the topographic map of the state in the least possible time.

Program

(Abstracts by the authors.)

Sulfofication in Soils: P. E. Brown and E. H. Kellogg.

The Des Moines Diphtheria Epidemic of 1912–13: Chas. A. Wylie.

Bacterial Content of Desiccated Egg: L. S. ROSS.

The results of about 550 examinations of liquid and of powdered egg are given. The problem of the effect of storage, both with reference to time and temperature of storage, is considered. Results obtained in the experiment show a more rapid diminution of bacteria in storage at incubator temperature than at room temperature. The conclusion is drawn also that good eggs carelessly handled during process of manufacture may show a greater bacterial content than eggs of suspicious quality if carefully handled during the process of breaking and drying. It seems possible that "spots" may be made into a desiccated product, which after storage for some time would give satisfactory results upon a quantitative bacterial examination.

An Incubator Opening to the Outside of the Building: L. S. ROSS.

An incubator was placed in the basement and from this a chute leads upwards and outwards to an opening in the wall of the building. The purpose of the device is to make it possible for physicians or officers of the city board of health to drop diphtheria culture tubes, submitted for diagnosis, into the incubator at any hour of the day or night.

U. S. Kelp Investigations in Alaska: ROBERT B. WYLIE.

The Pollination of Vallisnaria: ROBERT B. WYLIE.

Comparison of Field and Forest Floras in Monona County, Iowa: D. H. BOOT.

A study made during 1909 and 1910 of the floras of typical areas in Monona county, Iowa, to determine the relationship between them. Studies made of undisturbed prairie, both exposed and sheltered, of cleared forest land and of both exposed and sheltered forest show gradual transition in plant life from the most xerophytic to the most hydrophytic types of habitat. No sudden breaks occur as we go from one area to the next. Complete lists of flowering plants accompany the report.

The Origin of the Cocklebur: CLIFFORD H. FARR.

Notes on a Fossil Tree-fern of Iowa: CLIFFORD H. FARR.

The Myxomycetes of Puget Sound: THOMAS H. MACBRIDE.

Some Notes on the Ecology of Iowa Lichens: ZOE R. FRAZIER.

The following conclusions are suggested by the work for this paper.

Lichens vary in adaptation to habitat; this applies both to different species and to different individuals of the same species.

Variation in habitat is explained, at least in part, by structural adaptations. Lichens show a remarkable power of resistance to drouth.

Preliminary Report on the Flora of Linn County: ELLIS D. VERINK.

The Male Gametophyte of Arisæma: JAMES E. GOW.

Sunflecks: W. H. DAVIS.

Some Observations on Sycamore Blight and accompanying Fungi: J. P. ANDERSON.

Introduced Plants of the Clear Creek Canon: L. H. PAMMEL.

L. H. Pammel called attention to some of the introduced plants of the Clear Creek Valley, Colorado. The first botanist to visit the region was Dr. C. C. Parry, who collected in this region in 1861. Comparatively few alien plants have been introduced; many of the introduced plants are those common to the plains or boreal species.

Weed Survey of Story County, Iowa: L. H. PAMMEL AND CHARLOTTE M. KING.

This paper gives a brief summary of the ecological distribution of weeds on tilled and untilled land in central Iowa, using the quadrat method of giving the distribution.

Variation in Evaporation in Limited Areas: D. H. BOOT.

Notes on Variation in Micranthes Texana: L. A. KENOYER.

In southeastern Kansas there is a very small patch of a little saxifrage, *Micranthes texana* (Buckl.) Small. Saxifragaceæ are normally 2-carpellate, but in this patch the carpel number varies from two to six, fluctuating around three as an average. Of the 1,800 flowers examined, 83 per cent. have three carpels each. A mutation seems to have occurred somewhere in the life history of this rare and little-known species, giving rise to a group having three as the normal number of carpels.

Barium in Tobacco and other Plants: NICHOLAS KNIGHT.

Colloidal Common Salt: NICHOLAS KNIGHT.

The Sand of Sylvan Beach, New York: NICHOLAS KNIGHT.

Unusual Dolomites: NICHOLAS KNIGHT.

Electromotive Forces and Electrode Potentials in Mixed Solvents: J. N. PEARCE AND W. H. FARR.

Equilibrium in the System—Mercuric Iodide-Anilin: J. N. PEARCE AND E. J. FRY.

A complete curve representing the conditions of equilibrium between mercuric iodide and anilin has been plotted for temperatures between —11.48° and 199.9°. The region of stability of the three solids $HgI_2 \cdot 2C_6N_7H$, red mercuric iodide, and yellow mercuric iodide have been established. Sixteen solubility measurements of mercuric iodide in anilin are given, all in duplicate and mostly in triplicate. A new compound corresponding to the formula $C_6H_7N \cdot HG_2I_2$ has been identified and described. The compound $HgI_2 \cdot 2C_6H_7N$ has been made by direct combination of mercuric iodide with anilin. A method for the determination of mercuric iodide as mercuric sulphide in the presence of an easily oxidized organic solvent has been tested.

The Electrical Conductivity of Solutions on Certain Electrolytes in Organic Solvents: J. N. PEARCE.

Earth Movements and Drainage Lines in Iowa: JAMES H. LEES.

The paper aims to bring together existing knowledge concerning drainage conditions in northeastern Iowa and to show that the present system is the resultant of uplifts and warpings of the strata at different periods and from various centers. The fact that the streams are flowing far above the bottoms of their valleys is attributed to changes necessitated by glacial action and to lowering of the land surface.

Some Evidences of Recent Progress in Geology: GEORGE F. KAY.

In this paper reference is made to some of the most important geological papers published during the last ten years and which indicate the lines along which the greatest progress has been and is being made.

Siouan Mountains: An Iowan Triassic Episode: CHARLES KEYES.

The true significance of the abrupt cutting off to the northward of the Iowa belted Paleozoics is obscured by the fact that Cretacic sediments overlie points at which critical evidence might be expected. Lately, deep-well records and other data have disclosed a substructure that is quite remarkable. It is now known that over the high arch extending from Lake Superior southwestward into South Dakota the Cambric, Ordovicic, Siluric, Devonic and Carbonic formations were spread out. The uprising appears to have taken place in Triassic times; and in Comanchan time the entire mountainous ridge, 5,000 feet high, was planed off and completely base-leveled. Upon this peneplained surface the Mid Cretacic sediments were laid down. This period of base-leveling also appears to fix the date of peneplain forming the Lake Superior highlands.

Serial Unit in Stratigraphic Classification: CHARLES KEYES.

The recent movement to test the validity of each formational unit by criteria other than that of the contained fossils has led to important and rather unexpected advancements in stratigraphical classification. The fact that this movement is also in the direction of simplicity argues for its still wider adoption. In Iowa, Illinois and Missouri the Early Carbonic succession is a good illustration of the point under consideration. By emphasizing the paleogeographical and diastrophic factors and adapting, so far as is possible, the nomenclature already in use the various terranes may be grouped into three grand divisions having serial rank. These groups are the Waverleyan series, the Mississippian series and the Tennesseean series. At divers times other names have been proposed, that might be used but for the fact that they are preoccupied. The division is essentially the same as that first suggested by Owen more than sixty years ago.

Stratigraphic Position of Our Oldest Rocks: CHARLES KEYES.

Although the Sioux quartzite, which crops out where the three states of Iowa, Minnesota and South Dakota meet, has been long known and repeatedly described, little has ever been learned of its tectonic relationships or of its real position in the general geologic column. The Corson diabases, the Hull porphyries and the Tipton sandstones now appear to belong to the Keewenawan series of the Proterozoic era. The Split-Rock slates, the Sioux quartzite and the Jasper conglomerates are Animikean in age. The Archeozoic is not represented. The gneisses of Le Mars and the schists of Sioux City form a part of the Azoic complex.

On Precious Stones in the Glacial Drift: GARRETT A. MUILENBURG.

A New Section of the Railway Cut near Graf, Iowa: A. O. THOMAS.

This artificial section exposed along the Chicago Great Western railway in Dubuque county has been made famous by the writings of James and of Calvin. It has recently been cut back for quite a

distance while making some improvements in the road-bed.

The fresh section affords an excellent opportunity for studying this phase of the Maquoketa shales. Several feet of interesting beds higher up than those described by the writers mentioned have been exposed. The new section is described and a revised list of the fossils is given.

The Surface Clay of Adair County (Second Paper): JAMES E. GOW.

Evidences of Sand Dune Formation in Cedar Rapids and Vicinity: WASHBURN D. SHIPTON.

Pleistocene Exposures in Cedar Rapids, Iowa and Vicinity: WASHBURN D. SHIPTON.

Preliminary Report of Geological Work in Northeastern Iowa: ARTHUR C. TROWBRIDGE.

Field work is now being carried on in northeastern Iowa by students and faculty of the geology department of the State University of Iowa. Much new material is being found, along the lines of stratigraphic, structural, paleontologic, economic and physiographic geology. The region is particularly rich in physiographic problems, and a continuation of the work is expected to yield much additional knowledge of the Mesozoic and Cenozoic history of this part of North America.

The Origin of Eskers: ARTHUR C. TROWBRIDGE.

There are many difficulties with the generally accepted subglacial theory for the origin of eskers, which says that these interesting ridges are deposited by streams flowing beneath continental glaciers. It seems more likely that they are formed by the slow recession of the edges of glaciers during the deposition of kames, and a resulting drawing out of the kames into long lines.

An Area of Wisconsin Drift farther South in Polk County, Iowa, Than Hitherto Recognized: JOHN L. TILTON.

One mile south of the bridge over Raccoon River at Valley Junction there is a small area of Wisconsin drift about a third of a mile in diameter.

Indian Pottery of the Oneota or Upper Iowa Valley in Northeastern Iowa: ELLISON ORR.

The Oneota or Upper Iowa, a small river about eighty miles in length, flows through Winneshiek and Allamakee counties in Iowa close to their northern border, which is also the line between this state and Minnesota. It flows through a beautiful winding valley which has a width of half a mile, and is bounded by precipitous bluffs. The glacial terraces which extend up this valley for forty miles to Decorah have afforded very abundant evidences of a former considerable Indian population. Earth embankments, mounds and camp sites have yielded up a treasure of implements, weapons and ornaments. Notable among these are the large number of small earthen vessels found in burial places and the fewer large ones which seem to have been buried by themselves. The writer has been quite successful in finding or securing a number of well-preserved specimens of both classes, some of which he describes in detail. The material used in the manufacture was common clay tempered by pulverized clam shells. In shape this pottery is symmetrical but the attempts at ornamentation are crude. The vessels all have a rounded pot-like bottom and if upset, will at once resume an upright position. "In short, these prehistoric potters, while they were able to produce very shapely ware, were unable to add to its beauty by elaborate, intricate or symmetrical designs." The paper is illustrated by nine plates.

Longitude by Wireless: D. W. MOREHOUSE.

Illumination Power of Kerosenes Used in Iowa: WILLIAM KUNERTH.

The results of this series of experiments can be summarized as follows:

1. By the application of ordinary photometric methods great differences in the illuminating power of different samples of kerosene oils have been shown.
2. Oils from the east have a lower density and are sold at a higher price than those from the west.
3. Those oils which have a high illuminating power were found also to be high in density, index of refraction, viscosity, surface tension, flash point and burn point. The length of wick charred was shorter and the fogging of the chimney was more marked than for the oils having low illuminating power.
4. The oils which were retailed at lower cost gave more light.
5. By putting coloring matter into an oil the illuminating power is decreased.
6. By exposing oil to light, the illuminating power is decreased.
7. Draft reduces the illuminating power.
8. The denser the oil the greater is the intrinsic brilliancy of the flame.
9. Air in oil seems to decrease the illuminating power.
10. For a given flux of light the cost of illumination by kerosene oil lamps is about the same as that by tungsten lamps.
11. The oils used in this state have practically the same burning quality.
12. Kerosene oil lamps are not very desirable as standards of comparison.
13. The quantity of oil received for a gallon is often very deficient.

14. The lighter the oil the more nearly white is the flame.

Certain Diffraction Experiments in Sound: HAROLD STILES AND G. W. STEWART.

This paper describes three experiments in sound diffraction, viz., the shadow of a rigid sphere, the passage of sound through narrow slits and the sound through circular apertures.

Previous theoretical investigations are verified to within a reasonable degree in all three experiments. The paper is published in full in the *Physical Review* for April, 1914.

The Variation of Sound Intensity with Distance from the Source; An Interesting Case of Deviation from the Inverse Square Law: G. W. STEWART.

This paper shows that when a source of sound is located on a rigid sphere the intensity does not decrease inversely as the square of the distance from the source or from the center of the sphere. Data are given for the variation in intensity in different directions from the sphere, at different distances and with a variation of wave length.

Notes on the Construction of Selenium Bridges: E. O. DIETERICK.

The Adaptation of Selenium to Measurements of Energy Too Small to be Measured by Other Devices: L. P. SIEG AND F. C. BROWN.

The Effect of Pressure on the Light-sensibility of Metallic Selenium Crystals: F. C. BROWN AND L. P. SIEG.

Sex Linked Factors in the Inheritance of Rudimentary Mammæ in Swine: EDWARD N. WENTWORTH.

The Effect of Calcium and Protein Fed Pregnant Swine upon the Size, Vigor, Bone and Coat of the Resulting Offspring: JOHN M. EVVARD, ARTHUR W. DOX AND S. G. GUERNSEY.

To determine the relative effects of calcium and protein when added to a basal ration of corn when fed pregnant swine on the developing fetus many separate experiments were conducted. It was clearly shown that the addition of protein to corn increased the size, vigor, condition, coat quantity and coat covering of the offspring. Duroc Jersey swine were used; these are red in color. The addition of calcium also increased the size, vigor, condition, coat quantity and coat color, but not so markedly as did the protein. However, the calcium did have more effect on the bone development and the condition or degree of fatness than did the protein. That the addition of protein had such influence upon the offspring is due in large measure to the fact that the corn protein is deficient in the amino acids, tryptophane, lysine and glycocoll. The source of the protein was black albumen, whereas the calcium was furnished in the form of both chloride and carbonate. The carbonate was found to be more efficacious than the chloride, presumably because it did not induce acidosis as the chloride probably did.

A Study of the Crow: FRANK C. PELLETT.

Butterflies of Chance Occurrence in Cass County: FRANK C. PELLETT.

Nature and Birds: FRED BERNINGHAUSEN.

Color Vision in Animals: MABEL C. WILLIAMS.

Effect of Low Temperature on the Oyster-shell Scale, Lepidosaphes Ulmi Linn: R. L. WEBSTER.

The effect of the low temperatures of January, 1912, on the eggs of the oyster-shell scale in Iowa. An account based on samples of scale sent in a year later. In most cases the eggs had been killed by the severe winter.

A Catalogue of the Lepidoptera of Linn County: GEORGE H. BERRY.

Notes on Variation in Micranthes Texana: L. A. KENOYER.

Coleoptera of Henry County, Iowa: INEZ NAOMI KING.

There are listed about 500 species of Coleoptera representing those that are known to occur in Henry county, Iowa. Most of these species have been collected by the author during the years 1912, 1913 and 1914.

"The Coleoptera of Indiana," by W. S. Blatchley, has been used for the larger part in naming the specimens taken, although some of the names have been determined through various sources.

An Observation of Longitudinal Division of Hydra: L. S. ROSS.

An account of the observation of two specimens of the brown *Hydra* in the process of longitudinal division, one being divided through the length of the body to the foot, while the other had divided through the hypostome and only a short distance into the body. Also a brief account of the accidental injury of one of the tentacles resulting in the union of two tentacles into a loop that persisted a few days and then separated again into two distinct tentacles.

A Convenient Table for Microscopic Drawing: L. S. ROSS.

JAMES H. LEES,
Secretary

SCIENCE

FRIDAY, JULY 31, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MEMORIAL ON THE FOUNDATION OF AN INTERNATIONAL CHEMICAL INSTITUTE[1]

GENERAL

THE recent foundation with such exceptional rapidity and unanimity of the International Association of Chemic Societies shows that chemistry, as a science, has advanced to a position where unregulated individual efforts are no longer sufficient and must be replaced by organizing the efforts of all chemists.

The participants in that formative meeting held in Paris toward the end of April, 1911, had not given the subject much previous thought, nevertheless even in this preliminary discussion a large number of undertakings of general interest were mentioned which showed how keenly the need of organizing all chemic activities is felt.

Such possible and necessary undertakings of general value discussed in the proceedings are:

1. The uniformity of nomenclature of chemic substances.

2. The inclusion of the international committee of atomic weights in the Association of Chemic Societies.

3. Uniformity in the nomenclature of physic and chemic constants.

4. Conformity in the editing of tables of contents of chemic publications.

5. A standardization of the writing of abstracts and other reviews of the new publications in chemistry.

6. The preparation of an international auxiliary language for publications of universal interest.

7. Standardization of the size of publications.

8. Arrangements for limiting the printing of an article in different publications.

9. Preparation of a chemic thesaurus in which

[1] Translated by Adolf Law Voge.

the gist of all chemic knowledge will be presented in a clear and trustworthy manner.

If one compares this abundance of new problems to which a little thought would add many more, with the means at the disposal of the International Association of Chemic Societies, one perceives the great disparity between them.

Many of the undertakings suggested require for their execution an institute at some fixed place, in which the requisite accessories, primarily a permanent and exhaustive library of chemical literature, are at hand; and where the methods of executing these new and difficult tasks can receive systematic test and improvement. Besides the organization of the scientifically trained chemists of the world, which has been practically accomplished by the International Association of Chemical Societies, it seems absolutely necessary to consider the creation of an establishment to perform the tasks set by this general body.

Immediately after the adjournment of the Association in the first days of May, I undertook as a task logically resulting from the formation of the Association, to consider providing for that permanent work-place, and endeavored by means of a provisional plan of organization to discover whether and in what way this great new problem could be solved. Since I was almost immediately fortunate enough to discuss them at length with Ernest Solvay in Brussels, these plans gained greatly in clearness, and, I believe, in possibility for realization. This successful organizer at that time expressed himself as ready, if the arrangements decided upon met with his approval, to contribute toward the founding of the Institute, a quarter million francs ($50,000). Unfortunately because of the pressure of his various business interests he felt it necessary to decline the permanent directorship of such an institute, which at first there was a prospect of his assuming.

AN INTERNATIONAL INSTITUTE OF CHEMISTRY

I considered my plan further, and attempted by means of a number of different sketches for its organization to form a clear idea of the various possibilities.

The proposal here presented is the result of those considerations; and is merely intended at present to show the feasibility of the new project! Naturally, all sorts of impracticabilities will become incorporated in such a new conception. These will be recognized and remedied as the institute expands and evolves. However, even now we can form a general idea of the operation of such an international institute. Such an institute seems to me so appropriate and desirable, that I feel the time is come to transform thoughts into action. Chemic science should be provided as soon as possible with the exceptionally versatile and far-reaching aid which would come from such an institution.

TASKS OF THE INSTITUTE

To guard at the very beginning against possible misunderstanding it should be emphasized that the proposed International Institute of Chemistry is to be in a certain sense a complement to the institutes for scientific investigation which were founded on the occasion of the centennial of the University of Berlin. Not in the highest spheres of creative scientific work are to be the labors of the International Institute of Chemistry; on the contrary those tasks in the realm of chemical science which are ever recurring in the same form are to be carried out there once for all, and placed at the service of every one; especially the literary reference work and everything connected with it; that is, the most trivial and routine labors which are necessary for the advancement of the science. Consequently in the future it should be a fundamental

principle in our science that no task of this kind once carried out need ever be repeated, for the finished work should be kept continually and regularly at the disposal of those whom it concerns.

In other words the International Institute of Chemistry is to have a function similar to that exercised by the Reichsanstalt of Technology in the revision and correction of thermometers, voltmeters and other instruments. Formerly the correction of a thermometer or other measuring instrument was the work of many weeks, now it is done by the Reichsanstalt in a very short time, and with far greater accuracy than is possible to an isolated physicist.

In chemistry to-day, likewise, there are a large number of tasks which must be done over and over again by the individual, because what has once been performed is not always accessible to the public. Just as the Reichsanstalt of Technology can make the correction of thermometers much more certainly and reliably than the average physicist could (without a disproportionate expenditure of energy) because this mechanical work is done regularly and systematically at the central bureau so these eternally recurring chemic tasks could be incomparably better and more accurately carried out at a central bureau than by the average inexperienced chemist. And if the regret is voiced, as it has been to me, that the useful art of making effective collections of literature would be entirely lost through the founding of an international institute of chemistry, the answer is that the loss of the art would mean no actual loss at all. For once the International Institute of Chemistry is founded it will furnish a permanent and perpetual organ of the whole science, which will perform its special functions far better than isolated chemists have performed them, and which will therefore make this sort of skill in the individual absolutely superfluous.

In a certain stage of its development the human embryo has gills, inherited from its aquatic ancestors. No one laments the fact that these gills never develop. For the conditions of man's life have become such that those organs would never be used. So the existence of the International Institute of Chemistry will alter working conditions for the future chemist so that he will not need to acquire skill in the sort of work which can be done by the Institute far better, and it would be a waste of time and energy for him to try to acquire these obsolete functions. The more the individual chemist can be emancipated from such mechanical tasks which give a disproportionate amount of trouble because of their infrequency, the more time and energy he will have for the real investigation which depends on his special training.

THE ORGANIZATION OF THE SCIENCE

A process is going on in chemistry which we have often observed in other phases of civilization. A hundred years ago the housewife was obliged not only to make bread, but to dip candles and boil soap. To-day these duties have been taken from her by special manufactories, and she has leisure to devote herself with greater zeal and success to her duties in the domain of the rearing of children. In just the same way a division of labor is taking place in all other fields. Man is constantly becoming more and more a creature working only with his brains, who leaves mechanical or partially mechanical operations to machinery. It need not be further emphasized that by such systematic cooperation, by the development of highly developed organs, infinitely more can be accomplished than under the earlier conditions of haphazard individual work. In the history of chemistry we certainly can find instances where extremely difficult compilations were carried on at first by one man,

who with the growth of the work was obliged to surrender it for completion to a group of men. It is true that during the second half of his life Berzelius prepared the Jahresbericht; but in his later years it was clearly seen how impossible it was for a single investigator to retain the power of passing appropriate and unprejudiced judgment on all contemporary works. The Jahresbericht in so far as it still exists has long been the product of the cooperation of a specially trained group of men.

In precisely the same way the Index of Organic Chemistry was created by the indefatigable Beilstein, but to-day there is no scientist of equal caliber who can carry on this enormous work in the same spirit and with the same reliability. Here it has been necessary to intrust the continuation of the work of a single man to a whole staff.

All these instances show most clearly the need of an international general organization of chemic undertakings of this kind. The work done, for example, by the commission in preparing the supplement to the Beilstein Index is of benefit not only to the German chemists but to the chemists of the whole world, and should therefore be done not by a German, but by an international institute. The same holds true of all other general undertakings in chemistry; for chemistry, like every other science, is entirely independent of national peculiarities.

NEW FUNCTIONS AND ORGANS

It must not be forgotten, either, that the capacities which enable a man to prepare an ideal abstract or an ideal review are not those which distinguish the investigator and discoverer. The maturity of an organism is shown most clearly by its differentiation of function. This differentiation of function has no other purpose than the bringing about of greater efficiency through specially adapted organs. So too in the future International Institute of Chemistry, a special technique of collecting and abstracting will be evolved which will bring about far greater speed, completeness and reliability than appears possible with our hitherto somewhat haphazard methods.

We appreciate too, that this wearing and severe work of abstracting is almost always done by young men, who work only a few years, not with any idea of making it a profession—merely for the sake of eking out their incomes. As soon as the young man obtains a better position he renounces this work. Therefore proficiency in this work must continually be attained anew, so that no high degree of excellence is ever reached. But so soon as this kind of work is undertaken by specially fitted people as a life work, it will not only be incomparably better done, but there will be an ever higher standard of excellence in the individual production. Present-day abstracts, for example, leave a great deal to be desired, as every one knows who has been obliged to use them, because a scientific treatment of the question of what belongs in an abstract and what can be left out has actually never yet appeared. The individual abstractor is thrown on his own sense of fitness and such instructions as are vouchsafed him by the director when his errors are too flagrant. In the case of lifelong occupation with such problems, the technique of abstracting will be developed to a real science, and the workers whose scientific ambition is concentrated on this problem will be able to write abstracts which could actually supplant the original, because one could find in them with certainty the essential points of the original article. Such a technique is the more necessary because it has long been impossible

for the individual to keep pace with the progress of his science. He is dependent on abstracts, and moreover on their appearing with great promptness, if he would not lose his survey of the entire work of his field. So the work of abstracting to be organized in the International Institute of Chemistry will not only make the older literature specially accessible, but will satisfy this daily more pressing need in giving the investigator an exhaustive survey of his special problems, a survey which can reach according to requirements from the earliest times to the present. Any one who for scientific or economic reasons wishes to follow the progress of any special problem can be assured if he makes use of the Institute, that nothing of importance will escape his notice; but at present it is physically and financially impossible for an individual to have instant recourse to the existing literature of a subject.

NEW MEANS OF PUBLICATIONS

Since the present means of publication, the periodicals, yearly reviews, the monthly or quarterly compilation, the Zentralblatt, have shown themselves increasingly insufficient to the increasingly complex and urgent demands of science and technology, the developing science must create new organs of interpretation to make itself effective and can not delay till these organs are provided for it from without. As always with such innovations the need is seen much sooner than the means of satisfying it. There is no other way except for those men who have seen the need and discovered the means of its satisfaction, to produce those means even at considerable personal sacrifice. When the organ has begun its regular activity and shown its usefulness and indispensability, it will no longer be so difficult to obtain the necessary money for its support.

THE INTERNATIONAL INSTITUTE OF CHEMISTRY

The first thing then for us to do is to bring the International Institute of Chemistry so far into being that it can perform its real functions, and show clearly its advantages. Let that go on uninterruptedly for five to ten years, and it can safely be assumed that such an institution will show its public and general usefulness so plainly that public and general funds will be provided for its permanent maintenance.

On the other hand if it were premature or impracticable, time would show that too.

The benefits of such an institution would extend far beyond the circle of its own science, large as that circle is, thanks to the extraordinary development of chemistry in the last century.

But something similar to the systematization which is necessary in this special field is demanded by all other sciences and many other of the common interests of humanity. Because of the enormous facilitation of personal intercourse by trains and steamers and of intellectual intercourse by books, newspapers, letters, the telephone, the telegraph, the wireless telegraph, etc., mankind is concentrated into a much smaller space than formerly. The isolated groups, the nations, which were formerly separated by great distances, and possessed few interests in common, are suddenly forced into great interdependence, and the problem of organization, that is, the continual and regular connection of these groups of humanity is the most pressing problem of the time. Just as the science of chemistry will create in the International Institute its own organ for performance of tasks for the general good, so will similar organs be developed in the most various enterprises, and we chemists who originated the *Jahresbericht* as the first of its kind, will have the honor of doing pioneer service in this

field also—the organization of a whole science. It is true that many kinds of international scientific organizations will have preceded the International Institute of Chemistry. I need only mention the International Bureau of Weights and Measures in Sevres. But the work of independently organizing a whole science so that its mechanical functions will be completely taken away from the general public, may be called entirely new, and to those who perceive the necessity and practicability of such an organization and do their part toward its realization, will remain the incontestable honor of having done pioneer service in one of the most important departments of civilization of all humanity.

LOCATION OF THE INSTITUTE

We turn now to the question of the practical organization of such an institute.

It must be emphasized in the beginning that we are considering not a traveling, but a large permanent institute with numerous buildings, collections, laboratories, etc. The first question to be decided is that of the location. At first glance it seems a matter of indifference where it be placed, provided only certain general conditions be fulfilled. The institute must not be too far removed from some center of intercourse, that the necessary communication with the general public may be carried on without loss of time. We should agree that the institute must be located in Europe, because the greatest spacial density of chemical activity is in Europe, and the intercourse between the individual chemists and the institute could be carried on with the least possible loss of time. To be sure we recognize that a second center of gravity of chemic science and technology is to be found on the other side of the Atlantic Ocean in North America, and that the formation of a sister institution in America is essential. Such a sister institution would be specially advantageous because the work in common would be divided between the two institutes, and together they could cover the literature of the past in half the time. Meanwhile, for the reasons already given, it is Europe's duty and also her right to undertake the founding of the first institute, and to do the pioneer work in the execution of this plan. As regards the more exact situation of the institute, I have considered the neighborhood of Brussels, in the hope that Ernest Solvay would place his great talents as an organizer at the service of the institute. Since this hope can no longer be realized, the question of the location of the institute for the present is relegated to the background. The decision will depend largely upon where and how the funds for the institute are obtained.

DUTIES AND ARRANGEMENT OF THE INSTITUTE

On a suitable piece of ground of at least five hektares, in the vicinity of a great city, the buildings of The International Institute of Chemistry will be erected. Each department will be housed in a separate building, specially arranged and fitted out, but these buildings are to be so connected that the assistants can go from one to another without loss of time, and danger from exposure. So I planned to have the main building long and wide, built through the length of the grounds. From this, on either side, at suitable distances, will open the wings in which the departments of the institute are to be housed. The easy mode of communication between the wing buildings furnished by this corridor will be of primary importance in the operation of the institute.

I have considered the following departments, each of which will be housed in a separate wing.

CHEMICAL WORLD LIBRARY

A Library of the Entire Literature of Chemistry

I offer as a foundation for this library my private library of some 7,000 volumes and 12,000 pamphlets (dissertations). It contains the most important chemic and physic journals in complete or nearly complete series, as well as several thousand single volumes covering all fields of chemic science.

The expansion of this library which must have as its aim the possession of every book on any chemic subject, will take place partly through purchase, mainly through donations. Such gifts will often be made us by public-spirited chemists who many times are glad to get rid of duplicates, and books for which they have no use. Further, we anticipate that all chemists will give copies of their newly published work to the library, that publishers of periodicals, scientific societies and all other institutions, for the propagation of chemic literature, will place copies of their publications at the service of the institute free of cost. In this way the library can be maintained at a very slight cost. The presence of a new book in the library of the institute, instead of hindering its sale to private parties, will prove the best possible advertisement for publishers.

INDEX OF CHEMIC SUBSTANCES

This library will furnish the working material for two or three other departments.

First of all a card index of all chemicals will be prepared, according to the well-known principles of card-indexing. This will contain citations to all the literature on these substances. It will form automatically the foundation for a complete history of the study of chemical substances. This will do away with the necessity of those historic introductions with which chemic literature, particularly the dissertations, are so senselessly burdened, because every one will know that he can obtain a complete historic survey from the card catalogue of the institute. This department will furnish compilations of the entire literature on any chemic substance to any member of the institute, or any inquirer, for the cost of copying or gratis. How greatly this will facilitate scientific work will be appreciated by any one who has tried to collect the whole literature on some chemic subject. There is always the chance that something will be found of vital importance, which has been hitherto overlooked because there has been no systematic organization of all chemic literature.

INDEX OF TERMS

As a supplement to the card catalogue of chemic substances, there will be prepared a similar catalogue of all chemic terms. The terms, as well as the substances will first undergo a process of crystallization and purification. The history of the development of chemic terms is no less important than the history of the substances themselves.

INDEX OF PERSONS

The third and final collection will be an index of all chemists, dead as well as living. An exhaustive compilation will be made of the entire literature of each investigator who has taken or is taking part in the development of chemic science.

This will form automatically a directory of all chemists of the world who have published. Eventually it will be enlarged to embrace not only the chemists who have come in contact with printer's ink, but all who have in any way been connected with chemistry, pure or applied. The lists of members of all chemic societies, as they appear each year, will serve as foundation for this directory. So in the future it will be

possible for any chemist to communicate with any other chemist in the whole world.

THE ABSTRACTING DEPARTMENT

Chemists long ago realized how extremely uneconomically the abstracting of contemporary scientific literature is done. Not only is all chemic literature abstracted in German in the *Zentralblatt*, in English abstracted twice, once by the English and once by the American society, in French by the French societies, and in other languages, such as Italian and Russian, by their societies; there are in addition a large number of periodicals for special branches of chemistry which prepare quarterly, semiannual or annual bibliographies in their own fields. It can be said without exaggeration, that every article is abstracted on the average from five to ten times, and this so necessary work is done with from five to ten times too great an expenditure of energy. And withal the individual abstracts, for the reasons already given, are always more or less incomplete. If carried on by a central bureau, with assistants all over the world, if necessary, this work would be done for a small fraction of the present expense and far more quickly and accurately.

I realize that it will be some time before the centralization takes place, for the present institutions will not vanish at a word. But even those who cherish a prejudice against such centralization can not deny that with the rapid increase of chemic literature the old organizations will sooner or later prove inadequate, and a central organization become a necessity. It is always better to recognize such necessities as early as possible, because the changes can more easily be introduced when the material is not yet too overwhelming than when up to our necks in the water of chemic literature.

CHEMIC REFERENCE AND TEXT-BOOKS

From the reference department will come eventually the material for the great encyclopedia of all chemistry. In this book everything done and being done in the fields of chemic science and technology will be systematically compiled. Such a work would necessarily be of so enormous a scope that its complete publication could not be considered for the present. But it will exist in the form of the systematically arranged references in the International Institute of Chemistry.

There will, of course, be a second copy in America. It will be possible for any one who has a special interest in any question to have compiled for him the entire reference material on this subject. The Institute will make special arrangements for the copying of single portions of the complete work, at nominal prices which need scarcely cover the actual cost, so that any chemist can have access to the part of this huge work covering his own field.

It need scarcely be mentioned that smaller reference and text-books can be compiled from the same material. The preparation of the literary structure of all chemic texts would be placed on a much higher scientific and technical basis than at present. Now each individual author must write work all over again which has been written many times before, or lay himself open to the charge of plagiarism.

INTERNATIONAL AUXILIARY LANGUAGE

There would also be various departments for the more complete utilization of the work done by the main institution. I would mention specially the bureau of translation which, if necessary, could be later developed into the bureau of an international auxiliary language. The great variety of chemic literature which appears in different languages is very imperfectly utilized

for the advancement of the science. Whatever is published in Russian or Roumanian or some other little-known language is read only by a comparatively small circle and a translation into some more familiar language is necessary to add such articles, sometimes of very great value, to our stores of knowledge. In a paper which appeared in January in the *Zeitschrift fuer physikalische Chemie*[2] I worked out an international chemic nomenclature, founded on the world language Ido. I showed that a chemic nomenclature in a plastic, artificial language is better, more consistent and more comprehensible than in any natural language. With the comparatively limited range of terms and conceptions used in a special science like chemistry, the formation of an artificial language is a comparatively easy task. The attempts at the construction of some such universal means of communication, which have been made with increasing zeal during the last forty years have undoubtedly shown its practicability. Such an artificial language is far better suited to our purposes than any natural language. These facts are not so well known as they deserve to be. They are none the less true and will be confirmed by well-known members of our science.

So it is possible for us to make the intellectual treasures of our science equally accessible to all the chemists of the world through a common language. We need only choose one of the artificial systems already at hand. Because Ido is the only one in which a systematic chemic nomenclature has been worked out, we should turn our attention first to that scientifically perfected idiom.

THE COLLECTION OF CHEMICALS

The departments already described cover the literary side of science. Provision must also be made for the experimental practical side in such an international institute. Here the first essential is a complete collection of all existing chemicals of absolute purity and reliability. Such a collection would be made not only for systematic and didactic reasons. The chemist who happened in his experimenting to prepare a substance possibly never prepared by him before, could secure samples from the institute for comparison. Further, such samples would be of service when a determination of any physical properties of the substances was to be made. Every one who has done such work knows that the most arduous part is the preparation of the materials for the experiment while the actual determination of the properties is comparatively easy and rapid. Instead of preparing the same substance in one laboratory for the determination of the refraction coefficients, in another laboratory for the magnetic rotation of the plane of polarized light, and in a third for its absorption of ultra-violet or ultra-red light and so on, the collections of the International Institute could be used everywhere for the determination of all possible properties. The objection has been raised to this plan that there are numerous substances which can not be kept indefinitely without deterioration, and could not therefore be used satisfactorily for such purposes. The answer to this objection is that naturally a laboratory would be connected with this department where new substances could be prepared and where fresh materials could be produced and the purity of substances which were to serve in standardizing operations could be tested.

It must again be emphasized that the aim is far less to undertake pioneer investigations than to rationally support enterprises already mentioned, with the means at the disposal of the institute. This is to be done according to the fundamental prin-

2 Vol. 76, p. 1–20.

ciple that any sort of work which has once been satisfactorily performed is to be regarded as definitely finished for the whole science, and that such work be ever at the disposal of the entire science.

ROOMS FOR TRANSITORY WORKERS

Finally a special division of the institute must be mentioned, the necessity for which must often have occurred to any one who has attentively followed these considerations. It is the building in which simple rooms for the accommodation of transitory workers in the institute will be provided. The incomparable services which the institute would soon be in a position to render would not only offer opportunities to the regular assistants for pursuing their investigations, but would attract voluntary workers who wished to make use of the aids offered by the institute for their particular problems. The most liberal opportunities should be afforded them, for the institute is to stand at the service of the public.

Such people should be able to reside for a longer or a shorter time in the institute. The provision for them can be the simplest possible. A sufficiently large sleeping room with the necessary toilet arrangements is quite enough, for the work will be carried on in the different departments of the institute and the rooms need not be equipped for that purpose. Provision for serving meals should also be made so that the assistants can remain at the institute through the entire working day and obtain warm food when desired. This is an arrangement more advantageous to brain workers like those of the institute than it is to manual workers.

ORGANIZATION OF CHEMIC SCIENCE

Only the most important divisions have been mentioned, the development of which must be considered by the International Institute.

When these first, more important departments have become active, the other sides of the problem for the thorough organization of the institute must be taken up. Opportunity is afforded here for individual donors to endow parts of the work to which they are specially devoted.

This holds especially for the numerous and versatile fields of applied chemistry, which have not been mentioned in this paper. From this it is by no means to be inferred that they would be excluded from the institute. They have been omitted from the paper because the purely scientific field, being fundamental, must precede; and because the author is much less conversant with them than with pure science.

In the directing bodies of the International Institute (to be explained later) are to be representatives of applied chemistry and from their suggestions proper attention will be paid to these subjects.

In chemistry the pure and applied sciences are so happily affiliated that exemplary arrangements can be attained to more easily than in most other fields of applied science.

DIRECTION OF THE INSTITUTE

Again emphasizing the fact that the following is merely a suggestive plan evolved after long meditation and discussion, and is not at all to be regarded as a fixed unchangeable arrangement, I conceive of the International Chemical Institute being directed in the following way:

The higher direction of the institute will be entrusted to a triple presidency, one member of which will direct the scientific, another the economic and financial activities while the third will be the president of the International Association of Chemic Societies. The separation of the scientific

from the economic activity is a necessity. A distinguished president in one of these activities would scarcely prove an excellent one in the other; yet it is evident that both phases of the work must be executed with equal excellence. The need of the third member of the presiding body scarcely demands an explanation.

It is naturally necessary that there should be a close and carefully defined connection between the International Chemical Institute and the International Association of Chemical Societies. The International Chemical Institute is, so to speak, the executive for the widest needs of chemistry in general, as represented by the International Association of Chemic Societies. Through this constant connection of the Institute with the Association, joined to the annual change in the representative of the Association, a vivifying factor will be introduced in the Institute, so easily neglected when the management remains always the same.

To the president of scientific activities the directors of the different scientific departments will be subordinate. These directors will have independent control of their own sections. These latter should all be lifelong positions for which the most capable and experienced occupants must be found. Each departmental director will be served by a larger or smaller group of assistants according to the type of work of the department. Each of these departments must be operated efficiently and according to the most recent progress in technique—which goes without saying in an institute founded on truly scientific principles.

Further two more bodies could well be formed, standing in a freer relation to the institute. First, a scientific council which together with the president of the International Association of Chemic Societies will provide the Institute with requisite new suggestions, demands and methods. This will be an independent body formed of leaders in scientific and technical chemistry throughout the world. It will meet, say, annually for free discussion concerning the management and development of the Institute. Perhaps its function can be partly performed by the Council of the International Association of Chemic Societies.

A second similarly constituted body will be formed of those who have aided in founding and supporting the institute, through gifts of importance whether of money, materials, books, chemicals, etc. This body would support the president of finances as the other would the president of science and would act particularly when funds were to be secured, or the activity of the Institute expanded and new departments formed.

MEMBERSHIP OF THE INSTITUTE

Concerning the relation of the Institute to chemists the world over, I conceive of the following connection:

The extraordinary simplification and help which every one can obtain from the Institute for work in our field justifies a certain pecuniary support from those so aided. On the other hand it must be borne in mind that the majority of our colleagues are not in brilliant pecuniary positions so that this fee must be made relatively small. Yearly dues of one to two dollars could be borne by all whose work would be furthered by use of the institute and would be large enough to aid materially.

The membership of the chemic societies of the world is about 20,000; assuming that half of these became members of the Institute an annual fee of one dollar would yield a yearly income of ten thousand dollars; a two dollar fee yield twice as

much. That is a sum almost sufficient for the salaries of the staff, at first.

Unattainable in the first or second year, this membership should be reached in the fifth year of the Institute's existence; and after the first decennium the benefits of the Institute will have been so incontestably proven, that no chemist, whatever his activity, will find it practicable to carry out his work without using it. Then the annual membership fees would amount to much more than we have assumed.

CONDITIONS FOR THE FOUNDATION

The foundation of so great an institution is not possible on the uncertain basis of membership fees. A realization of the entire plan can only be expected when a definite sum of money has been assured for the first outlay, and a yearly income guaranteed for a number of years.

After repeated calculation of the requirements and conditions and with the feasible assumption that nothing need be allowed for the purchase of the land, I assume that with an endowment of $150,000 and an annuity of $12,000 for five or ten years, the Institute could be called into being without subjecting ourselves to the stigma of financial rashness.

Neither sum can be obtained except through the willing participation of those persons and institutions who would derive personal or public benefit from the International Chemical Institute or who wished to serve as public benefactors.

Personal solicitations will be instituted to obtain this endowment for the establishment of the International Chemical Institute.

The liberality of one or another country will eventually decide where in Europe the main institute is to be located.

WILHELM OSTWALD

THE MAN OF PILTDOWN

THE story of the Piltdown discovery is already more or less familiar to readers of this journal.[1] But the recent gathering and publishing of additional data[2] on the subject should not be allowed to pass unnoticed. This is especially true not only because of the far-reaching significance of the discovery, but also because British scientists have been known to be at odds concerning the reconstruction of the skull in question.

It will be recalled that Dr. Smith Woodward regarded the Piltdown specimen as the type of a new genus of the family Hominidæ, to which he gave the name *Eoanthropus dawsoni,* and which was defined primarily by the characters of the mandible. Of the mandible only the right ramus with first and second molar teeth *in situ* was at first discovered. The condyle and symphysis were both lacking, but the fragment was of sufficient size to enable Dr. Smith Woodward to reconstruct the symphysis with a fair degree of accuracy. It was the reconstruction of the cranium about which differences of opinion arose between Dr. Smith Woodward and Professor Elliot Smith, on the one hand, and Professor Arthur Keith, on the other.

Of the brain case nine fragments, parts of the frontal, parietal, occipital and temporal, were found. From these Dr. Smith Woodward reconstructed a skull with a capacity of about 1,076 c.c. On the other hand, a reconstruction by Professor Keith gave to the skull a brain capacity of 1,500 c.c., in other words, that of a well-developed modern European skull. After further study Dr. Smith Woodward acknowledges a small error. He finds that the "longitudinal ridge along the outer face at the hinder end of the parietal region is not median, but one of a pair such as frequently occurs in the lower types of human crania." In the published reconstruction there should thus be a slight readjustment of the occipital

[1] SCIENCE, January 17, 1913.

[2] Chas. Dawson and A. Smith Woodward, "Supplementary Note on the Discovery of a Palæolithic Human Skull and Mandible at Piltdown (Sussex)," *Quar. Jour. Geol. Soc.*, LXX., April, 1914.

and right parietal bones, "but the result does not alter essentially any of the conclusions already reached."

With this opinion Professor Elliot Smith is in complete accord. From an examination of the original fragments, he was able to determine the location of the median line of the skull. The persistence of slight traces of the sagittal suture in the regions of the bregma and lambda made this possible. The true median plane in this particular case, however, passes a little to the left of the union of the coronal with the sagittal suture owing to a slight deflection of the latter. Since this deflection is never more than a few millimeters (except where large bregmatic wormian bones are present and they are not present in this case), the bregma and lambda are good guides in locating the median plane. In line with the median plane as thus determined, the endocranial aspect of the frontal bone presents a well-defined longitudinal ridge, corresponding to the "place where the two halves of the frontal bone originally came together at the metopic suture." The cranial capacity then of the Piltdown skull is evidently not very much greater than the original estimate of 1,076 c.c.

In addition to exhaustive laboratory studies on the parts above mentioned, a painstaking and systematic search was made at the Piltdown site. The mandibular ramus had been found *in situ*. All the gravel *in situ* within a radius of five meters of this spot was "either washed with a sieve or strewn on specially prepared ground for the rain to wash it; after which the layer thus spread was mapped out in squares, and minutely examined section by section." In this spread Father Teilhard de Chardin, assisting at the work for three days, found the right canine tooth in August, 1913. The two human nasal bones and the turbinated bone were not recovered from this spread, but from disturbed gravel within less than a meter of the spot where the mandible had been discovered.

The nasal bones are said to "resemble those of existing Melanesian and African races, rather than those of the Eurasian type." In thickness they correspond to the bones of the skull previously found. The canine tooth not only corresponds in size to the mandible, but belongs to the same half (right) as that recovered. It likewise agrees with the two molar teeth in the degree of wear due to mastication. The extreme apex is missing, but whether by wear or by accidental fracture is not determinable. The enamel on the inner face of the crown has been completely removed by wear against a single opposing tooth. The worn surface "extends to the basal edge of the crown, as indicated by the clear ending of the cement along its lower margin."

This canine tooth is larger than any human canine hitherto found, and interlocked with the opposing upper canine. It rose above the level of the other teeth and was separated from the lower premolar by a diastema. On the other hand, there is no facet due to wear against the outer upper incisor, such as often occurs in the apes.

If a comparative anatomist were fitting out *Eoanthropus* with a set of canines he could not ask for anything more suitable than the tooth in question. It conforms to a law in mammalian paleontology, "that the permanent teeth of an ancestral race agree more closely in pattern with the milk-teeth than with the permanent teeth of its modified descendants." The canine of *Eoanthropus*, as might have been expected, resembles the milk canines of *Homo sapiens*, on the one hand, and *Simia satyrus*, on the other, than it does the permanent canines of either. It is pointed out that even in recent man if the base of the crown of the canine were raised in the gum to the same level as that of the adjacent teeth, its apex would frequently rise well above the rest of the dental series.

The various elements that make up the gravel bed at Piltdown are better known to-day than when the first report was published; additional fossil animal remains have also been recovered. Four well-defined layers have been determined. At the top is a deposit of surface soil 35 cm. thick, containing pottery and flint implements of various ages. The second bed consists of undisturbed gravel varying from a few centimeters to a meter in thickness.

The prevailing color is "pale yellow with occasional darker patches." A rude paleolith of the Chellean type was found in the middle of this layer, which likewise contained rolled iron-stained subangular flints. The third layer, some 50 cm. thick, is easily distinguished because of its dark ferruginous appearance. It contains rolled and subangular flints similar to those found in the layer above. All the fossils (with the exception of the remains of the deer) were either discovered in or have been traced to this third layer. So-called eoliths and at least one worked flint were likewise found here. The *Eoanthropus* remains came from it and near the uneven floor forming the upper limit of the fourth stratum. The latter has a thickness of about 25 cm., is non-fossiliferous, and "contains flints of a much larger size than any of those in the overlying strata." Nothing that could be called an implement or eolith has been reported from the fourth bed. Below are undisturbed strata of the Tunbridge Wells Sand (Cretaceous).

Our knowledge of the Piltdown fossil fauna has been supplemented by the finding of remains of one new form, a fragment of a tooth of *Rhinoceros,* in the same state of mineralization as the teeth of *Stegodon* and *Mastodon* previously described; while the specimen can not be determined with absolute certainty, it belongs either to *Rhinoceros mercki* or *R. etruscus,* with the evidence rather favoring the latter. Additional remains of *Stegodon* (fragment of a molar) and *Castor* (fragment of mandible) were likewise recovered. Judged from its fossil content, the third stratum at Piltdown would be classed as Pliocene were it not for the presence of *Eoanthropus* and the beaver. In view of the fact that the remains of these, although softer, are not so rolled and worn as the other fossil remains, the third bed, although composed in the main of Pliocene drift, was probably reconstructed in early Pleistocene times.

Those who might once have objected to the use of the name *Eoanthropus* for the Piltdown skull can no longer deny its appropriateness when applied to the lower jaw, especially since the finding of the canine tooth. While the probabilities are all in favor of the three parts belonging to one and the same individual, the case for *Eoanthropus* does not have to depend on producing positive proof to that effect. The only flint implement of Chellean type came from the layer above (No. 2), and is of later date than the human remains. Did *Eoanthropus* make use of the eoliths found in tell-tale association with him? The future holds this secret, and if hard enough pressed, may some day reveal it.

George Grant MacCurdy
Yale University,
New Haven, Conn.

THE PRODUCTION OF COAL IN 1913

The production of coal in the United States has again broken all previous records, the output for 1913 being 570,048,125 short tons, which is considerably more than double the production of 1900 and more than eight times the production of 1880, according to a statement just issued by the United States Geological Survey, from figures compiled by Edward W. Parker, coal statistician. The value of the coal mined in 1913 is given as $760,488,785.

Compared with the previous year the output for 1913 shows an increase of 35,581,545 tons, or nearly 7 per cent. The increased activity indicated by these figures was well distributed throughout the 29 coal-producing states, 23 of which showed increases and only 6 decreased production, the decrease in one of these—Colorado—being due solely to labor trouble. Of those showing increase, 12 made record yields, and Pennsylvania, the leading coal state, broke records in both bituminous and anthracite production. The states which broke all former records in coal production were Alabama, Illinois, Kentucky, Montana, New Mexico, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia and West Virginia. The largest increase in the production of bituminous coal was in Pennsylvania, where 11,915,729 tons was added to the output of 1912. West Virginia showed the second largest gain, 4,522,295 tons, and Kentucky the

third largest gain, 3,126,079 tons, which was also the largest percentage of increase, amounting to 19 per cent., of all the important coal-producing states. Indiana was fourth, Illinois fifth, Ohio sixth, and Alabama seventh. While the total increase was very large as figured in tons, the percentage is what may be considered normal and indicative of healthy industrial activity throughout the country.

Coal mining, like all other industries in the Ohio Valley states, was seriously interfered with by the great floods during the spring of 1913, and Mr. Parker estimates that from 5 to 10 million tons of coal would have been added to the year's output but for this disaster. With no violent fluctuations in the demand by the blast furnaces, steel works, and other manufacturing industries, the demand for coal for those purposes shows only a normal increase. The continued decrease in the use of fuel oil in the Mid-Continent oil field and the strike in the Colorado coal mines resulted in an increased output of coal in the central and southwestern states. With a few exceptions, notably in Illinois, Indiana and Oklahoma, values ranged higher than in former normal years, so that from the producers' standpoint the conditions in 1913 were fairly satisfactory.

The development of our coal-mining industry with reference to population presents some interesting comparisons. In 1850 the coal output was 7,018,181 tons, or 0.3 ton for each of the 23,191,876 inhabitants; in 1880 the population had increased to about 50,000,000 and the production of coal to about 71,000,000 tons; an average of 1.42 tons per capita. At the close of the nineteenth century the population was 76,303,387, an increase of a little over 50 per cent. as compared with 1880, while the production of coal had increased nearly 400 per cent. in the same period and averaged 3.53 tons for each person. In 1913 the per capita production was figured at 5.85 tons. In addition to this increase in the consumption of coal, the use in recent years of petroleum and natural gas should also be considered.

The coal mines of the country gave employment in 1913 to an army of nearly three quarters of a million men—747,644. The average number of days worked by the bituminous miners in 1913 was 232, against 223 in 1912, while the average time made in the anthracite mines in 1913 was the best on record—257 days for each man. The average production per miner in the bituminous mines increased from 820 tons in 1912 to 838 tons in 1913, both being record-breaking averages, while anthracite miners increased their average from 485 tons in 1912 to 532 tons in 1913.

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

THE board of scientific directors of the Rockefeller Institute for Medical Research announces the following appointments and promotions:

Dr. Hideyo Noguchi, hitherto an associate member in the department of pathology and bacteriology, has been made a member of the institute.

Dr. Alfred E. Cohn, hitherto an associate in medicine, has been made an associate member for the term of three years.

Dr. Wade H. Brown, hitherto an associate in the department of pathology and bacteriology, has been made an associate member for the term of three years.

The following assistants have been made associates:

Harold Lindsay Amoss, M.D. (pathology and bacteriology).

Arthur William Mickle Ellis, M.D (medicine).

Thomas Stotesbury Githens, M.D. (physiology and pharmacology).

Israel Simon Kleiner, M.D. (physiology and pharmacology).

Alphonse Raymond Dochez, M.D. (medicine). Dr. Dochez has also been appointed resident physician in the hospital to succeed Dr. Swift.

The following fellows have been made assistants:

Frederick Lamont Gates, M.D. (physiology and pharmacology).

Louise Pearce, M.D. (pathology and bacteriology).

The following new appointments are announced:

Chester Harmon Allen, M.S., fellow in chemistry.

Alan M. Chesney, M.D., assistant resident physician and assistant in medicine.

Harold Kniest Faber, M.D., fellow in pathology.

Ross Alexander Jamieson, M.D., assistant resident physician and assistant in medicine.

Benjamin Schönbrun Kline, M.D., fellow in physiology and pharmacology.

John Jamieson Morton, Jr., M.D., fellow in pathology.

James Kuhn Senior, M.A., fellow in chemistry.

Joseph Richard Turner, M.D., fellow in pathology.

Dr. Paul Franklin Clark, formerly associate in pathology and bacteriology has been appointed assistant professor of bacteriology in the University of Wisconsin. Dr. Homer F. Swift, formerly resident physician in the hospital and associate in medicine, has been appointed associate professor of Medicine at the College of Physicians and Surgeons, Columbia University, and associate attending physician, Presbyterian Hospital.

SCIENTIFIC NOTES AND NEWS

The Society of Chemical Industry has awarded its medal to Sir Henry Roscoe, its first president, for his services to science.

Mr. Douglas Freshfield has been elected president of the Royal Geographical Society in succession to Lord Curzon.

The technical school at Dantzig has conferred the honorary degree of doctor of engineering on Dr. Walther Nernst, professor of physical chemistry at the University of Berlin.

In addition to the honorary degrees already noted in Science as conferred at the tercentenary celebration of Groningen University, there were conferred degrees in the sciences on two other Americans; on Professor Edward B. Van Vleck, professor of mathematics at the University of Wisconsin, and on Mr. Edward Phelps Allis, the zoologist, who resides at Mentone, France.

Dr. Henry Winston Harper, professor of chemistry in the University of Texas, received the degree of doctor of laws, from Baylor University, at its recent commencement.

On the recommendation of the committee on awards of the scientific exhibit, of which Professor Richard M. Pearce of the University of Pennsylvania was chairman, at the recent Atlantic City meeting of the American Medical Association, the first prize, the gold medal for the best scientific exhibit, was awarded to Miss Maude Slye of the Otho S. A. Sprague Memorial Institute of Chicago, for her exhibit of charts, diagrams, specimens and tables on the transmission of hereditary cancer and other diseases in mice.

Dr. Camillo Golgi, professor of pathology at Pavia, known especially for his investigations on the minute structure of the brain, celebrated his seventieth birthday on July 7.

Dr. Myles Standish, Williams professor of ophthalmology in the Harvard Medical School, has been appointed professor emeritus.

A complete list of American scientific men who have accepted invitations to attend the Australasian meeting of the British Association as the guests of the New Zealand government, is as follows:

Dr. L. H. Bailey, Ithaca, N. Y.; Mr. Lyman J. Briggs, Department of Agriculture, Washington, D. C.; Professor A. P. Coleman, Toronto University, Toronto; Dr. Edwin G. Conklin, Princeton University, Princeton, N. J.; Dr. Charles B. Davenport, Cold Spring Harbor, Long Island, N. Y.; Professor William M. Davis, Harvard University, Cambridge, Mass.; Dr. George A. Dorsey, Curator of Anthropology, Field Museum, Chicago; President G. C. Creelman, Ontario Agricultural College, Guelph, Ontario; Professor R. T. Ely, Madison, Wisconsin; Professor E. C. Franklin, Leland Stanford University, Palo Alto, Cal.; Professor P. H. Hanus, Harvard University, Cambridge, Mass.; President E. F. Nichols, Dartmouth College, Hanover, N. H.; Dr. Ira Remsen, President, Johns Hopkins University, Baltimore; Professor William M. Wheeler, Bussey Institution, Forest Hills, Boston.

Professor F. P. Leavenworth, of the University of Minnesota, is spending the summer at the Yerkes Observatory in working with the micrometer and the forty-inch telescope.

Professor C. H. Eigenmann has been appointed research professor of zoology in Indi-

ana University for the year 1915 and is accordingly relieved from all teaching. He plans to devote all but three or four months in completing his studies of the distribution of the fishes of western Ecuador and western Colombia and its bearing of this on the east and west slope fauna of Panama. He intends to spend the winter months in correlating the freshwater fauna of the lesser Antilles to that of South America.

WE learn from the *Geographical Journal* that the *Amnauer Hansen,* a small boat of about 50 tons, only some 75 feet long, started from Plymouth at the beginning of June for a two months' scientific cruise in the Atlantic. The scientific work will be under the direction of Professor Helland-Hansen, director of the Marine Biological Station at Bergen, and Professor Fridtjof Nansen and his son accompany the party. The expenses of the cruise have been partly defrayed by the Nansen fund, and the program includes observations of ocean temperatures, currents, salinities, light penetration and so forth. The vessel is constructed on the same principle as a Norwegian lifeboat, and is worked partly by motor and partly by sail.

DR. W. S. BRUCE, of Edinburgh, has left the Tyne on an expedition in the waters of Spitzbergen. It is his intention to proceed to Tromsö, where the expedition will be finally fitted out. A number of motor-boats will be used by the party. The expedition, which will last several months, will be occupied with a series of extensive soundings in the neighborhood of Spitzbergen and with the effort to chart a number of islands not at present on the maps of mariners.

PROFESSOR ELLSWORTH HUNTINGTON, of Yale University, lectured before the students in geography and geology in the Columbia University Summer Session on July 20, on "Climatic Changes and their Geographic Effects."

THE scientific society Antonio Alzate, Mexico City, celebrated on July 6 the tercentenary of the discovery of logarithms by John Napier, when a commemorative address was made by Señor Don Joaquin de Mendizabel y Tamborrel.

MRS. POYNTING has presented the scientific library of the late Professor J. H. Poynting to the physics department of the University of Birmingham.

DANIEL A. CARRION, a medical student in Lima, Peru, inoculated himself in 1885 with blood from a verruga tumor in an effort to throw light on the nature of the disease, and he died from it in less than two months. The sixth Pan-American Congress held at Lima last year started a fund for a monument to this young martyr to science, and subscriptions are now being received. The fund is in charge of the dean of the medical faculty, Professor E. Odriozola, Lima, Peru.

DR. NICHOLAS LEQUARRÉ, formerly professor of the history of geography at Lüttich, has died at the age of eighty-one years.

DR. NICOLAS JEAN-BAPTISTE DUGNET, vice-president of the Paris Academy of Medicine, died on July 4, at the age of seventy-seven years.

MISS L. E. LAWRENCE and Miss M. W. Lawrence have presented £4,000 to the Royal Society to devote the interest to the furtherance of research into the cause and cure of disease in man and animals. The donors desire to associate the gift with the memory of their father, Sir W. Lawrence, F.R.S., and their brother, Sir Trevor Lawrence.

THE Ernst Haeckel foundation for monism has transferred to the University of Jena $75,000, for the *Phyletische Archiv,* a publication of the Phyletische Museum established by Professor Haeckel.

THE Smithsonian Institution gave in the auditorium of the U. S. National Museum on July 16 an exhibition of motion pictures taken below the sea at the Bahama Islands, by the Submarine Film Corporation.

AT the second Congress for Radioactivity and Electronics held in Brussels in the year 1910, the following committee was appointed to make arrangements for the third congress: M. Curie, Paris, E. Rutherford, Manchester, I. E. Verschaffelt, Uccle (Belgium), E. v. Aubel, Gent, A. Righi, Bologna, W. Wien, Würzburg, F. Exner, Vienna, B. B. Boltwood,

New Haven, P. de Heen, Sclessin (Belgium), and the following medical gentlemen: J. Daniel, Brussels, W. Deane Butcher, London, L. Bergonie, Bordeaux, C. Lester, Philadelphia, E. Ludwig, Vienna, W. His, Berlin, A. Bayet, Brussels, L. Hauchamps, Brussels. It has been decided to hold the third congress in Vienna from June 27 until July 2, 1915, to be composed of two sections: I. Physical and Chemical Section; II. Biological and Medical Section. The following officers have been elected: *President,* Professor Sir Ernest Rutherford, Manchester; *General Secretary,* Professor Stefan Meyer, Vienna; *Sectional Secretaries,* I. The general secretary and D. V. Hess, Vienna; II. E. v. Knaffl-Lenz, Vienna. The Scientific Committee are: Section I., M. Curie, Paris; F. Exner, Vienna; E. Rutherford, Manchester; W. Wien, Würzburg. Section II., P. Degrais, Paris; W. His, Berlin; H. H. Meyer, Vienna; G. Riebl, Vienna; E. Williams, Boston.

WE learn from *Nature* that the commonwealth of Australia, in connection with the approaching visit of the British Association, has issued a "Federal Handbook," describing the continent in its scientific and historical aspects. This book contains in a compressed, but readable, form more information than is elsewhere accessible. Among the more important articles may be noted that on history by Professor Ernest Scott; on physical and general geography by Mr. Griffith Taylor, and a very useful account of the culture and beliefs of the aborigines by Professor Baldwin Spencer. The book is at present issued only in a limited edition, but it may be re-issued to meet the wants of a wider public.

AT the forty-fourth Fruit Growers' convention held at Davis, California, June 1–6, the plant pathologists of California and neighboring states met and formed a local society to be known as the Western American Phytopathological Society. The purpose of the society is to hold meetings annually or semi-annually for the discussion of plant disease problems, to bring together workers for mutual assistance and stimulation. The territory which the society proposes to cover is in a general way that from the Rocky Mountains westward to the Pacific coast of the United States, Canada and Mexico. The society is to consist of members of the American Phytopathological Society located in the general region and associate members chosen by the membership committee. In addition to the practical plant disease discussions presented to the fruit growers at Davis, several more technical papers were presented. R. E. Smith, Berkeley, California, was elected president; H. S. Jackson, Corvallis, Oregon, vice-president, and Wm. T. Horne, Berkeley, California, secretary-treasurer. Preliminary arrangements were made for a meeting at Corvallis, Oregon, during next winter.

THE Paris correspondent of the *Journal* of the American Medical Association writes that there were 745,539 living infants born in France last year as contrasted with 750,651 in 1912. No lower total has ever been registered, with the exception of the year 1911. In recalling the steady fall in the French birthrate, it will be enough to mention that the annual average of living births was 945,000 during the period from 1872 to 1875; that, since 1907, the number of births dropped below 800,000, and since 1911, below 750,000. This means that in less than forty years the French births have diminished by more than 200,000 a year. The proportion of living children to every ten thousand inhabitants was 188 in 1913, instead of 190 in 1912, 187 in 1911, 196 in 1910, and 205 in 1906. The decrease, therefore, is accentuated each year. It is true that the birthrate is falling in all the large countries of Europe, but the proportion is much less than in France; and, moreover, the excess of births over deaths is proportionately five or six times greater. Thus, for the year 1912, the excess of births over deaths for each ten thousand inhabitants was only 15 in France; in the same year it was 158 in Holland; 140 in Italy; 130 in Hungary; 127 in Germany; 107 in Austria, and 105 in England. Last year showed an excess of 41,901 births over deaths, or only 10 for each ten thousand. The excess in 1912 was 57,911, or 15 per ten thousand. This diminu-

tion is due to a deficit of 5,112 births and an increase of 10,989 deaths. The departments in which the birthrate exceeds the deathrate are those of the north, Pas-de-Calais, Brittany, the frontier regions of the northeast, Limousin and Corsica. On the other hand, the valley of the Garonne, Normandy, the plateau region of Langres and Dauphiny continue to lose ground. The number of deaths (703,638) is greater by 11,000 than that of 1912, which was lower than any recorded number since the opening of the nineteenth century. The proportion of deaths to the population is 178:10,000, as against 172 in 1912, 196 in 1911 and 179 in 1910. The mortality has increased in 64 departments, and particularly in Bouches-du-Rhône, Dordogne, Var, Haute-Savoie, Corsica, Somme, Haute-Vienne, l'Aveyron and Tarn-et-Garonne. In 1913, 298,760 marriages were recorded, or 13,169 less than in the preceding year. The proportion of the newly married for each ten thousand has dropped from 158 in 1912 to 151 in 1913. The number of divorces has increased by about 500; 15,076 were recorded in place of 14,579 in 1912. The increase has therefore continued; in 1900 there were but 7,157 divorces; in thirteen years the number has more than doubled.

THE University of Chicago Press announces for fall publication the first two titles in the University of Chicago Science series. The size of the books will be 100 to 150 pages, duodecimo. The books that are ready for publication are: "The Origin of the Earth," by Thomas C. Chamberlin, head of the department of Geology in the University of Chicago; and "Isolation and Measurement of the Electron," by Robert A. Millikan, professor of physics in the University of Chicago.

THE Smithsonian Institution has issued a treatise on "Atmospheric Air and its Relation to Tuberculosis," by Dr. Guy Hinsdale, as one of the prize essays on that subject presented in connection with the Washington Tuberculosis Congress. The book including 136 pages of text and 93 plates of illustrations, forms publication 2,254 of the Smithsonian Miscellaneous Collections. It is not a public document and is distributed free only to libraries and specialists.

UNIVERSITY AND EDUCATIONAL NEWS

IT is proposed to establish a school of public health at the University of Minnesota, and a meeting was held to discuss plans for the school, July 13. The instruction is to be entirely by the present teaching staff, and will include the consideration of the subject from a medical as well as from a modern sanitary engineering standpoint.

SCHOLARSHIPS have been awarded by the Educational Fund Commission, of which Dr. John A. Brashear is president, to the teachers of the public schools of Pittsburgh, for the summer session of various educational institutions as follows:

Commonwealth Art Colony, Boothbay Harbor.	4
University of Michigan	2
North American Gymnastic Union, Indianapolis, Ind.	1
Chautauqua Institution, Chautauqua, N. Y.	10
University of Chicago	11
Columbia University	21
Cornell University	16
Dartmouth	4
Harvard University	14
Zanerian College of Penmanship, Columbus Ohio	3
Ocean City Summer School	3
University of Pennsylvania	4
Pennsylvania State College	7
University of Vermont	4
University of Pittsburgh	4
American Institute, Northwestern University.	1
University of Wisconsin	11
University of Berlin, Germany	1
University of New York	1
N. Y. School of Fine and Applied Arts	1
Munich Trade School, Germany	1
Total number of teachers sent in 1914....	124

REGISTRATION for the summer quarter at the University of Chicago has been announced, and an increase over the attendance of a year ago is shown. The total number of men registered on July 3 in the graduate school of arts, literature and science was 726 and of women 421, a total of 1,147; in the senior and junior colleges 1,249 men and 942 women, a total of 2,191; in the professional schools (divin-

ity, law, medicine and education) 577 men and 669 women, a total of 1,246; and excluding duplications, the registration for the entire university amounts to 1,696 men and 1,598 women—a grand total of 3,294.

Dr. A. I. Ringer, instructor in physiological chemistry at the University of Pennsylvania, has been elected assistant professor in physiological chemistry in the University of Pennsylvania School of Medicine.

Dr. Eugen von Hippel, of Halle, has been called to the chair of ophthalmology at Göttingen, in succession to his father, Dr. Arthur von Hippel, who retires at the close of the present semester.

Dr. Franz Keibel, of Freiburg, has been called to the chair of anatomy at Strassburg, as the successor of Professor G. A. Schwalbe.

DISCUSSION AND CORRESPONDENCE

TIN DISEASE AND POLAR EXPLORATION

It will be recalled that the Scott and Amundsen Antarctic expeditions were greatly handicapped by losing their petrol. Amundsen stated in one of his lectures in America that their petrol tins required frequent resoldering. According to the diary left by Captain Scott this " mysterious loss of petrol " was one of the chief contributory factors in their failure to return to safety.

In Scott's diary[1] of the return journey under date of February 24, 1912, he states:

> Found store in order except shortage oil—shall have to be *very* saving with fuel—. . . . Wish we had more fuel.

Again on February 26 he states:

> The fuel shortage still an anxiety. . . . Fuel is woefully short.

On March 2:

> We marched to the (Middle Barrier) depot fairly easily yesterday afternoon, and since that have suffered three distinct blows which have placed us in a bad position. First, we found a shortage of oil; with most rigid economy it can scarce carry us to the next depot on this surface (71 miles away).

[1] "Scott's Last Expedition," Scott, Huxley and Markham, p. 398.

March 4:

> We can expect little from man now except the possibility of extra food at the next depot. It will be real bad if we get there and find the same shortage of oil.

On March 7:

> If there is a shortage of oil again we can have little hope.

In his message to the public Scott says:

> We should have got through in spite of the weather but for the sickening of a second companion, Captain Oates, and a shortage of fuel in our depots for which I can not account. . . .

In Note 26 of the Appendix, the authors, Huxley and Markham, state:

> At this, the barrier stage of the return journey, the southern party were in want of more oil than they found at the depots. Owing partly to the severe conditions, but still more to the delays imposed by their sick comrades, they reached the full limit of time allowed for between depots. The cold was unexpected, and at the same time the actual amount of oil found at the depots was less than they had counted on. . . .
>
> As to the cause of the shortage, the tins of oil at the depot had been exposed to extreme conditions of heat and cold. The oil was specially volatile, and in the warmth of the sun (for the tins were regularly set in an accessible place on the top of the cairns) tended to become vapor and escape through the stoppers even without damage to the tins. This process was much accelerated by the reason that the leather washers about the stoppers had perished in the great cold. Dr. Atkinson gives two striking examples of this.
>
> 1. Eight one-gallon tins in a wooden case, intended for a depot at Cape Crozier, had been put out in September, 1911. They were snowed up; and when examined in December, 1912, showed three tins full, three empty, one a third full, and one two thirds full.
>
> 2. When the search party reached One Ton Camp in November, 1912, they found that some of the food, stacked in a canvas "tank" at the foot of the cairn, was quite oily from the spontaneous leakage of the tins seven feet above it on the top of the cairn.
>
> The tins at the depots awaiting the southern party had of course been opened and the due amount to be taken measured out by the supporting parties on their way back. However carefully

re-stoppered, they were still liable to the unexpected evaporation and leakage already described. Hence, without any manner of doubt, the shortage which struck the southern party so hard.

That the oil could have soaked the supplies placed seven feet below the oil tins by escaping through the stopper in the form of vapor, seems impossible. A possible and very plausible explanation of this leakage of oil is the conversion of ordinary tin into the allotropic form, gray tin powder. This change to gray tin powder is known to take place at a maximum rate at —48° C. and may take place more slowly at other temperatures below 18° C. Should this change occur along the soldered seams of the container, the mysterious leakage of oil might well be explained. This peculiar disintegration of tin is also shown by certain alloys of tin. Articles of pewter (tin 4 parts, lead one part) have frequently been known to show such changes and this change has indeed been given the name "museum disease," referring to pewter articles. Farup[2] claims that the admixture of other metals influences the rate at which said change occurs and in the series zinc, cadmium, copper, silver, lead, the accelerating influence increases in the order given, lead having the greatest accelerating effect. Since hard solder may contain 65 per cent. tin and since pewter is known to show this property, it may also be expected in such a hard solder. If such is the case, it is a good indication of the extreme care which must be exercised to meet the severe and unusual conditions surrounding polar exploration.

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CUBIST SCIENCE

THOSE stanch defenders of the citadel of pure science, who have so long arrayed themselves against the insidious invasion of metaphysics, must now arm themselves to repel a new foe. This is nothing less than that *dernier cri* of esthetic literature—cubism! Those who have come in contact with the cubist literature of Gertrude Stein or her disciples and imitators will recognize at once the diagnostic symptoms of infection in an article by P. C. van der Wolk in one of the most sober journals of genetics.[1] This paper is entitled "New Researches into Some Statistics of *Coffea*." Note the apparent innocence of the title. Here are some excerpts:

> In both of the former communications we saw how that generally the different curves, *within* the definite end curve, are present in a greater or smaller number of removings; the tops of the different curves remove in all directions, whereby the crucial point is still that the place of those tops is not so arbitrary. . . . I thought in the beginning to have an instance in which all the curves exhibited precisely the same top as was the case with the first four curves. Suddenly however halfway up the tree, the top thrust out a large distance to the right side, and to my astonishment the consequent curves as well as the definite end curve exhibited exactly the same top as curve 5. It is noteworthy that this top-removing happened *suddenly, without transition*. . . . Let us now refer back to both of the previous investigations. We then once more observe all those analyzed curves. Is there then a difference in principle between this newly recorded case and all the others? Is there a difference in principle in the question whether it is *only once* that a top-removing of the curves occurs within the end curve (as in our present case) or that *several times* top-removing takes place (as is the case in the two previous communications). Certainly not. [Italics are the author's.]

The scientific world will await with renewed interest this author's fourth communication, which we understand is to be a statistical study of top-removing in *Cannabis indica*.

J. F. A.

MOTIONS OF ATMOSPHERE

TO THE EDITOR OF SCIENCE: Recent letters from mathematicians and physicists seem to show that there are very few students or professors in our universities who pay much attention to the difficult problems that refer to motions of the atmosphere on a large scale. But surely there must be some physicists who

[2] *Cf.* "Handbuch d. Anorganische Chemie," Abegg, III_2, pp. 550.

[1] *Zeitschrift für Induktive Abstammungs- und Vererbungslehre*, 1914, XI., p. 355 ff.

are giving atmospherics close attention, even though the problems do seem too difficult for them to handle, either in printed memoirs or in lectures before their classes. I beg to utilize the columns of SCIENCE in an effort to ascertain the existence of such scholars and to solicit their cooperation with me in an endeavor to stimulate the study of the motions of the atmosphere.

The U. S. daily weather map of the northern hemisphere and *The Monthly Weather Review* will undoubtedly be useful to all earnest students.

CLEVELAND ABBE

SCIENTIFIC BOOKS

The Fungi which Cause Plant Disease. By F. L. STEVENS, Ph.D. New York, The Macmilan Co. 1913. Pp. 754. Figs. 449. Price $4.00.

Eighteen years ago the classic work on "Pilzpärasitaren Krankheiten der Pflanzen," by Frank, made its appearance, while the "Diseases of Plants Induced by Cryptogamic Parasites," by von Tubeuf and Smith, was published a year later. Despite the fact that a number of efforts have been made within the last few years by American writers, pathologists in general have been still looking for a new work that would satisfactorily supplant these older volumes. Stevens has entered the field with another volume which is intended to supplement his earlier and less technical work on "Diseases of Economic Plants." In the words of the author, "effort has been made to avoid duplication of matter contained in that volume." It is to be regretted that but little of the mycological and pathological activities of the past three years will be found in this new work (1911 in part only). This is to be deplored, since plant pathology has been passing through a period of rapid progress. It will perhaps be only fair, however, to overlook this shortcoming in passing judgment on the work in question. To what extent these two volumes will meet the expectations and needs of American students time alone will reveal. Perhaps we are expecting too much, but our mind has pictured the old classics as but stepping stones to the desired goal.

This new volume includes keys to the orders, families and genera of Myxomycetes, Schizomycetes and Eumycetes containing parasitic species. According to the author's statement, "Nonparasitic groups closely related to those that are parasitic have been introduced in the keys merely to give a larger perspective to the student." Directing our attention to the Ascomycetes, we may note that the keys are in the main translations from "Die natürlichen Pflanzenfamilien," with omissions and abbreviations, and occasionally the introduction of new genera. Parallel choices are indicated by marginal indentation, the characters employed in the original being omitted. Turning to the Fungi Imperfecti, we find that after the key to the hyaline-spored Sphæroidaceæ which follows Engler and Prantl quite closely, the keys appear for the most part to be transcriptions from Clements's "Genera of Fungi" with only slight modifications. The student who can steer his way through the key to the hyaline-spored Sphæroidaceæ without becoming lost in a bewildering tangle of spores, pycnidia and stromata, would deserve early election to Sigma Xi.

It is not possible to enter into a detailed discussion of the keys, but it seems that the author has relied too much on keys published some years ago, so that they are not always in harmony with our present knowledge. For example, "Conidia not in pycnidia, dark brown" is used as the key character for *Melanconis* (p. 279), although it is now known that certain species produce pycnidal (*Fusicoccum*) and acervular (*Coryneum*) stages.

According to the keys the vegetative body of the Schizomycetes is a "single-walled cell" (p. 3); *Næmospora* is placed under the division with muticate conidia (p. 538), probably correctly, but the text description says "with a bristle at each end." This genus is given under both the Hyalosporæ and the Scolecosporæ (pp. 538 and 562).

The experienced mycologist makes little use of keys, but when he does care to use them he will certainly go to the original. The prin-

cipal advantage of the present volume is that it does make the keys available for students who have no knowledge of German or Latin, but such students are out of place in mycology or pathology.

Speaking of the work as a whole one is impressed with the number of its typographical errors. It is not difficult to find pages with three to four each, and their character leads one to suspect that they are not entirely printer's errors. Many are more striking than the use of a wrong letter in a word. The following serve to illustrate the type: *host* for bast; *perithetical* for perithecial; *epithelium* for epithecium (see also author abbreviations).

There is an apparent tendency to exclude from consideration the species of fungi parasitic only on wild hosts of no economic importance, although this practise has not been rigidly followed. In genera containing many species these appear to be presented in kaleidoscopic succession—if there is any logical arrangement either alphabetical, host, phylogenetic or according to importance we have not been able to detect it. The descriptions are especially full in those groups which have been monographed somewhat recently.

Attention will be directed to a few of the remarkable statements which have attracted the writer's attention. "Tubeuf ranks as *hemi-parasites* those organisms that usually are parasites, but may sometimes become saprophytic, and as hemi-saprophytes such as are usually parasitic, but may exceptionally become saprophytic." It is fortunate that this definition is followed by the statement that "these distinctions are of little import" (p. 2). Teachers of botany will probably be impressed by the rarity with which *hypha* is used in the text, and the apparent application of the term to spore-bearing branches only (pp. 60 and 477). The statement that "the oogonium becomes free just before conjugation" (p. 74) gives a mixture of isogamy and heterogamy in the terms employed, while the information that "sexual spores (zygotes) are produced through the union of the two like gametangia" (p. 102) could have been presented in less objectionable form. The description of *Sclerotinia trifoliorum* Erik, is followed by the strange statement: "Unknown on clover" (p. 143).

In the face of the general consensus of opinion in America that the chestnut blight fungus belongs to *Endothia,* it seems strange that the author accepts Rehm's classification. According to the description of the blight fungus the perithecia are "deeply embedded in the inner bark," the summer spores are "pale yellowish," and "the perithecia appear in abundance upon or in cracks in the bark, extruding their spores in greenish to yellow threads" (p. 208). This is indeed quite a contrast to the true condition: perithecial stromata erumpent from beneath the periderm, ascospores forcibly expelled, and pycnospores hyaline.

The student's conception of the morphology of the promycelium will be a little mixed when he reads: "In every species the mycelium eventually gives rise to teliospores, which produce in germination four basidia, either remaining within the spore-cell or borne in the air on a short promycelium, each basidium supporting a single-stalked or sessile basidiospore" (p. 324). "Morphologically the promycelium is a basidium bearing its four sterigmata and four basidiospores" (p. 326). In various species of rusts the "peridia are scattered over the whole of the foliage" (p. 356) or "in elongated patches" (p. 376).

One may read that the hymenium of *Hydnum* is "beset with pointed spines" (p. 414); that the young hyphæ of *Fomes fraxinophilus* "are very fine and require an immersion lens for observation" (p. 434); also of the "Oospora forms of the Erysiphales" (p. 474).

The statement that "*Phleospora moricola* (Pass.) Sacc. on Morus is a conidial form of *Septogloeum mori,*" another imperfect fungus, is hardly in accord with mycological practise.

Considering the chaotic condition of mycology, it is not surprising that some species are duplicated or listed under the wrong genera. We may note, for example, that *Septoria cerasina* Pk. (p. 520) is described without any

intimation that it is synonymous with *Cylindrosporium padi* Karst. (p. 562). *Phyllostica hortorum* Speg. is given with no reference to the European work which showed that this egg plant fungus is an Ascochyta (p. 487). *Strumella sacchari* Cke. is listed as the only representative of the genus (p. 656), although it has been definitely shown that this fungus should be referred to *Coniothyrium*.

The author has very consistently followed the practise of decapitalization of specific names throughout the text, and for this he should be commended, although the rules of nomenclature dictate otherwise. It is difficult, however, to understand why species names became sufficiently important in the index to be uniformly capitalized! The very general botanical practise of italicizing binomials has been completely ignored, and will probably meet with little approval. The misspelling of scientific names is altogether too frequent. These are well illustrated by *"Pithiacystis citriophora"* (p. 77) and *"D. wilkomii"* (p. 144).

It is to be hoped that the accuracy of the author citations for the binomials is not indicated by the entire lack of any regular and consistent practise in their transcription and arrangement. Without regard to the length of the author's name, it is abbreviated (Sh. = Shear) or written out in full (Müller-Thurgau, p. 148). The same author's name may be written in full or abbreviated in a variety of ways, and in many cases these abbreviations are not in accord with mycological practise (*e. g.*, D. By., DeB. = De Bary; E. & H., E. & He., Er. & Hu., = Eriksson and Henning.) There are numerous cases of full names terminated by a period, indicating an abbreviation, and dozens of abbreviations without a period, indicating the full name of an author. Thus the amateur reader might wonder who Prill, West, Hohn, March, Plow, Rost, Berk, Karst, Heuff and others were, while for Frank., Brizi. and Petch., he might imagine the existence of such mycologists as Frankenstein, Brizioski and Petchnikoff. There are many errors in the spelling of author abbreviations, and in some cases they bear little resemblance to the original (*e. g.*, Farm. = Farneti; Hu. or Hem. = Henning; Fes. = Fries; Car. = Carvara; Gus. = Güssow; Ren. = Reinke; Heuff. = Heufler; Nebr. = Neuman.)

The profusion of illustrations (Figs. 1–449) certainly adds greatly to the value of the book. They are drawn quite extensively from American authors and are in the main well chosen. But in the Fungi Imperfecti many of the figures taken from Lindau's treatment in "Die natürlichen Pflanzenfamilien" appear rather crude. The author's effort to include "at least one illustration of each genus that is of importance in the United States" is a very commendable feature.

The illustrations are reproduced with the original figures or letters used in their explanation, even though in some cases (Fig. 288) they may be almost microscopic in size. The presence of numbers and varieties of figures and letters not used in the legends (*e. g.*, Figs. 9, 82, 88, 275, 413, etc.) may not be of any harm but they give a scrap-book appearance. The explanations of figures are in many cases too short (Figs. 13, 20, 129, 145, etc.) or incomplete (Fig. 351). There is no uniform style of punctuation in the legends, great variety prevailing (*e. g.*, Figs. 179, 198, 200, 421). Apparently the author has not been able to entirely discard the old practise of calling a pycnidium a perithecium (Fig. 354, also p. 493).

It would seem a little questionable to use a figure of a germinating teleutospore of *Gymnosporangium* (Fig. 266) showing two promycelia from a single cell in a work which should present the typical rather than the abnormal.

Following the customary practise, the illustrations are credited to various writers. If the student should assume the authenticity of the acknowledgments, as he naturally would, he would get some wrong ideas of the photographic activity of at least one author. Fifteen half-tones of basidiomycetes are presumably "after Clements." Five of these can be found in Freeman's "Minnesota Plant Diseases" as "Originals," one is from Lloyd,

one from Hard and four are from Atkinson's "Mushrooms."

According to the preface, "abundant citations to the more important papers are given, sufficient, it is believed, to put the student in touch with the literature of the subject." These are distributed through the book as five separate bibliographies, one for each of the principal divisions or classes, with a list of "some of the most useful books," at the end of the volume. It is difficult to detect any principle that has been followed in the selection of references, since some very unimportant work is cited while the student is left in the dark concerning the sources of information for some more important fungi.

The citations in the five general bibliographies are in neither alphabetical arrangement nor chronological order, but are listed in part in the order in which they are used. The climax is reached in the list of "some of the most useful books," 1–29 being arranged alphabetically by authors, while 30–64 are apparently not arranged at all. From 1–46, the author's initials, when used at all, stand first, while from 47 to the end the reverse order is followed.

Referring to all the bibliographies, it can be very emphatically stated that clearness is sacrificed for brevity. There is much waste space on each page that might have been utilized to good advantage. At the beginning of the first bibliography a key is given to the abbreviations used for the U. S. Department of Agriculture and Experimental Station publications, and a few of the more common serials, and this is followed by a statement that "other abbreviations are those usually employed or readily understood." This can hardly be true unless the book is used by students gifted with more than ordinary insight. It is extremely doubtful if such citations as the following would be clear to the average student: "O. E. S. B. 33: 308. 1896; Mo. Fruit B. 17: 1910; B. S. M. d.Fr 8: 22, 1892; Agr. Soc. 8: 292, 1894; N. S. R. Wales, 93; Unt. 9; F. B. 238: 14, 1907; Rept. Mic. Vio., N. S. Wales, 1909; Zeit. f. L. u. F. 408, 1910; Ruhland, Diss. 1903." The bibliographies contain numerous errors, typographical or otherwise, and there is at least one "Miss. Kew" (p. 111). The omission of the initials of authors in many cases is a confusing feature, and the errors of punctuation give some rather odd combinations (*e. g.*, Farlow, W. G. B. Bussey, Inst., 415, 1876; Detmers, O., B4; 1891). When a personal knowledge of an author is necessary in order that one may correctly interpret a citation, the beginner is certainly subjected to an unnecessary and an unjust handicap.

In the literature citations the author in many cases does not even follow his own key. For example, C. Bak. is given as the abbreviation for the Centralbl. f. Bakt. etc., II Abth., but this publication is listed also in four other ways. In the various bibliographies thirteen different combinations of abbreviations are used for the Berichte d. Deutsch. Bot. Gesellschaft, but first place must be assigned to the Bulletin Trimestriel de la Société Mycologique de France with nineteen combinations ranging from the simple to the complex.

The incompleteness of many of the references leads one to fear that many may be second-hand, and that they were never verified. The defects pointed out greatly impair the usefulness of the bibliographies.

A glossary of mycological terms precedes the index. The value of such a feature can not be disputed, but in this case clearness has again been sacrificed to brevity and there are too many instances in which only half the truth has been told (*e. g.*, stroma). Some adjectives are defined like nouns (*e. g.*, autœcious, cytolitic), while a noun may be defined as an adjective (*e. g.*, endophyte). The amateur who relies on this glossary will expect to find catenulate spores "linked as in a chain." or may be looking under leaves for parasites that are designated as hypophyllous.

The use of a single index, rather than separate host and parasite indices is a commendable feature.

In conclusion the writer must express his surprise that any firm with the reputation of the publishers would permit a book containing so many errors to pass through their

hands. They certainly owe to the author and American pathologists a speedy revision.

F. D. Heald

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Philadelphia, Pa.

A New Era in Chemistry. By Harry C. Jones. New York, D. Van Nostrand and Company. 1913. Price $2.00.

It is expected of a book written by a teacher and investigator so eminent as Professor Jones that it will be written in a clear, enthusiastic and readable style, and especially that it will be scientifically accurate and sound. That the book meets some of these expectations no one can doubt who reads Professor Howe's very laudatory review in the December number of the *American Chemical Journal.* The present reviewer, however, while recognizing merit in the book, certainly believes that no author should be permitted to go uncriticized who is so careless of his statements as is the author of "A New Era in Chemistry."

Among many other passages in the book which are open to criticism the following have been selected as representative.

In discussing the formula for benzene on page 12 the author says: "The study of the substitution products led to the conclusion that three carbon atoms in benzene are different from the other three. . . ." Whatever may be the final outcome of recent work in this field, it is certainly well known that the study of benzene and its substitution products led neither Kekulé nor any of his contemporaries to any such conclusion.

On pages 51–52 is given an inadequate, even quite erroneous, account of the stereochemistry of tartaric acid. The author writes, "Tartaric acid is especially interesting, having the constitution. . . . We see that it contains not only one asymmetric carbon atom, but two. These would have the opposite effects upon a beam of polarized light; the one half of the molecule turning it in one direction, and the other half turning it by an exactly equal amount in the opposite direction. The result would be that the substance would be racemic or optically inactive." Certainly no one can get any clear conception of the stereochemistry of tartaric acid from such a description.

Speaking, on page 63, of the one degree of freedom in the two-phase-one-component system, water and water vapor, the statement is made that "we can vary either the temperature or pressure, but varying the one we fix the other." And on the next page, in discussing the triple point, the author writes: "We can not move the point T in any direction without destroying the equilibrium. . . ."

These are very careless statements, both telling what does not take place. What the author intends to say with respect to the former is that a change either of the temperature or the pressure brings about a concomitant change in the other. With respect to the latter it may be noted that T, the triple point, is a fixed point and therefore can not be moved. A change of temperature or pressure brings about the disappearance of one of the three phases, but does not move the point T.

On page 281 we read, "It [radium] is everywhere, also, in atmospheric air"; and on page 273 it is stated that the alpha particle "carries one positive charge of electricity." Radium apparently does occur nearly everywhere, but its presence in the atmosphere is yet to be demonstrated. The alpha particle carries two charges, not one.

The following, taken from pages 273, 277 and 287, are given as examples of careless statements. No objections are raised concerning what the author probably intended to say: "Radium is naturally radioactive as it is called." "A radioactive substance is one that gives off radiations. . . ." "The best method used was the ice calorimeter." "A gram of radium therefore liberates about eighty calories of heat every hour, during its whole life history." "The largest amount of radium emanation thus far obtained is only a fraction of a cubic millimeter; and, yet, this gives off three fourths of all the heat liberated by radium." A gram of radium liberates heat at the rate of "about" eighty calories per hour so long only as it remains sensibly a

gram. The expression "during its whole life history" has no meaning whatever in this connection. Concerning the last of the above statements it may be said that undoubtedly the equilibrium quantity of radium is meant, but it is not so stated.

On page 287 it is said that "the radium emanation induces radioactivity on all objects on which it is deposited." It is the disintegration products of the emanation which are deposited, and not the emanation itself. The next sentence, which reads, "This induced radioactivity decays or disappears, as the emanation which causes it decays," while perhaps not entirely wrong, certainly does not state the facts clearly.

In discussing the disintegration of radioactive substances the author uses the expression "life history" sometimes to mean the "half period" of Rutherford, as, for instance, on page 283, when he speaks of thorium emanation as having a much shorter "life history" than radium emanation; at other times, as on page 288, it is apparently synonymous with "mean life," for he here speaks of 2,000 to 3,000 years instead of 1,760 years; while in another place, pages 294–295, he uses the expression with obviously still another meaning, for he here says that "the life history of radium is between two and three thousand years. This means that none of the radium now present existed more than twenty-five hundred years ago." There may be a legitimate sense in which one may speak of the "life history" of a radioactive substance, but certainly the expression should not be used in place of "mean life" or "half period." It may be remarked that, quite contrary to the above statement of the author, a very considerable proportion of the radium now present in the earth's crust was in existence twenty-five hundred years ago.

In the judgment of the reviewer the author also indulges far too freely in sweeping, unqualified statements. As an example of such a statement the following is quoted from the chapter on the "Origin of Stereochemistry," page 58. "Kekulé had converted empiricism in the study of carbon into system. Van't Hoff had made possible the beginning of a science of organic chemistry." Most organic chemists will probably say of this, that while there is possibly a difference in degree, there is hardly a difference in kind between the achievement of Van't Hoff and that of Kekulé.

Another example is taken from page 137. "It (water) owes its existence to the fact that hydrogen and hydroxyl ions can not remain in the presence of one another uncombined." This, of course, in a sense, is true. But then the following equally impressive statement is also true. Hydrogen chloride owes its existence to the fact that, depending upon conditions, chlorine and hydrogen ions can or can not remain in the presence of each other uncombined, which is equivalent to saying that hydrogen chloride owes its existence to the fact that it is hydrogen chloride. Moreover, hydrogen and hydroxyl ions can and do exist together uncombined, and it is to this fact that the many important phenomena of hydrolysis are due.

It is always of doubtful expediency to criticize an author's English; nevertheless, the reviewer ventures to quote the following from pages 117 and 268:

"Take, for example, water. We would find most of the hydrogens united with oxygen to form molecules of water; but, in addition, we would have some free hydrogens and some free oxygens."

"Take a salt like potassium chloride. When it is thrown into water an electron passes from the potassium over to the chlorine. The chlorine having received an additional electron thus becomes charged negatively, while the potassium having lost an electron becomes charged positively. . . . Take, again, a salt like potassium sulphate. Each potassium loses one electron to the SO_4, which thus acquires two negative charges, the potassium having each one positive charge." If this sort of description is justified by its directness and dramatic effect, then perhaps the only criticism to be offered is that "potassium" (four lines above) should read "potassiums."

One is disappointed after reading of the

dramatic manner in which Kenjira Ota arrived upon the scene of his labors, pages 148–150, to find him accomplishing nothing more remarkable than the measurement of the freezing points of certain solutions.

In view of the fact that none of the author's own investigations have been in the field of radioactivity, it seems rather remarkable that the references, pages 260, 261 and 296, to the author's book on the "Electrical Nature of Matter and Radioactivity" are not supplemented by the titles of well-known standard works on the subject.

However, the reviewer does not wish to be understood as wholly condemning the book. Far from it. The idea of writing a book on a "New Era in Chemistry" is an excellent one, and the story, for the most part, is most interestingly told, but at the same time it is the reviewer's conviction that no one who permits so many inaccurate, careless and exaggerated statements to creep into his work should go unrebuked.

The book closes with an appendix in which are given some delightful personal reminiscences of the great men who made possible the "New Era in Chemistry."

Edward C. Franklin

Rays of Positive Electricity and their Application to Chemical Analysis. By Sir J. J. Thomson. Longmans, Green & Co. 1913. Pp. vi + 132. Price, $1.40.

The day of the monograph in physics is apparently here, and it will be hailed with delight not only by physicists, but also by workers in all of the neighboring sciences. For in a period like the present in which new material is appearing very rapidly, and in which the "accumulation time" of new viewpoints is extraordinarily short, it is of the utmost importance that the results of recent research be got as quickly as possible in some form which is intermediate between the journal article, with its inaccessibility and incompleteness, and the general treatise with its rigidity and inertia. Monographs of the sort which Longmans has announced, dealing with half a dozen of the more recently developed departments of physics and written by men who have been prominently identified with their development, will appeal to a wide audience.

And if the whole Longmans series is as good as the first number, the publishers, the authors, the editors and the public may all congratulate themselves. For Sir J. J. Thomson has done his very best work, so it seems to the reviewer, on positive rays, and the present monograph is a fascinatingly simple and straightforward account of that work, introduced by a discussion of the preceding work of Goldstein and of Wien, and supplemented by a chapter on the Döppler effect with positive rays, discovered and investigated chiefly by Stark and his pupils. If any one has had doubt about the effectiveness of the positive-ray method as a means of discovering the sorts of atoms and molecules which constitute the residual gases in discharge tubes, and the values of the electrical charges carried by these atoms and molecules, he should take enough time to study carefully the five plates of actual photographs contained in this book. The parabolas shown in these photographs are about as convincing evidence as could be desired.

R. A. Millikan

SPECIAL ARTICLES

DESICCATION OF CERTAIN GREGARINE CYSTS

In connection with other studies on the cephaline gregarine *Stylocephalus giganteus* Ellis some data have been collected during the past fall concerning the viability of the cysts of this sporozoon and the effect of dryness on the formation of sporocysts. This gregarine is a common parasite in the alimentary canal of the Tenebrionid beetles of the genera *Eleodes* and *Asida,* so abundant in the semi-arid plains of eastern Colorado.

The cysts of *Stylocephalus giganteus* are subspherical, about 450 microns in diameter and opaque white when first discharged from the host. Unlike the cysts of many species of gregarines, they are not provided with thick, gelatinous envelopes, their walls on the contrary, are quite thin, the gelatinous envelope

if present at all being reduced to a thin film. If placed in water immediately after being discharged from the host, the cysts remain unchanged in external appearance for 4 days or more. After about 5 days the formation of sporocysts has progressed to such an extent that the cysts begin to turn gray, changing gradually to jet black in the next 2 or 3 days. Shortly after reaching the jet-black stage the cysts dehisce by simple rupture, discharging the long chains of ovoid sporocysts. Ten days usually elapsed between the time the cyst left the host and dehiscence, and no cyst examined dehisced in less than 8 days.

By starving the hosts it was found that the cysts were discharged in numbers almost free from excrement, and that such fluid excrement as did accompany the cysts dried rapidly, leaving the naked cysts glued to the glass tubes in which the hosts were confined. On September 23, 1913, several *Eleodes* sp. which had been starved for five days were placed in clean test tubes and over fifty cysts collected. The fluid excrement surrounding these dried in less than three hours, leaving the naked cysts adhering to the walls of the tubes. The beetles were removed and the tubes loosely plugged with cheese cloth. After plugging the tubes they were returned to the rack and allowed to remain undisturbed for 138 days. During this time they were in the light that came in through a north window, but not in direct sunlight, and were subjected to severe drying, as the room in which they were kept was heated with dry air, which together with the naturally dry air of Colorado dehydrated the cysts to such an extent that they shriveled and fell to the bottom of the tubes. On January 23, 1914, such cysts as had fallen to the bottoms of the tubes were removed and examined. All were still white, showing that the last stages of sporocyst formation had not been reached, and all were much shriveled and wrinkled, being reduced to half or less of their original volume. The dry cysts were then placed in water and after twenty-four hours' soaking they resumed their original spherical shape, still remaining white. By the end of the second twenty-four hours in water they had turned dark gray, and on the third day all were jet black, some having dehisced the long chains of ovoid sporocysts. From the time of discharge from the host to dehiscence these cysts were in fluid excrement for less than three hours, in dry air for 138 days and in water for less than three days. During the period of drying they did not lose their vitality and sporocyst formation was not completed. That internal changes had taken place in spite of the dry air is suggested by the rapid completion of sporocyst formation when the cysts were placed in water, dehiscence taking place in three days as compared with maturation period of ten days required by cysts taken directly from fresh excrement and placed in water.

This ability of the cysts of *Stylocephalus giganteus* to withstand a certain desiccation is perhaps an important factor in the distribution of this parasite which is so generally successful in eastern Colorado. Two stages at least, the cyst and the sporocyst, and possibly a third, the sporozoite, must be considered as distributional stages, comparable to some extent to those stages of many parasites which are passed in the secondary hosts. Each cyst of *Stylocephalus giganteus* produces an enormous number of sporocysts, which, as in most species of gregarines, are well protected by tough coats, and from the standpoint of species distribution both the number of sporocysts and their tough, protective coats are presumably positive factors in increasing the chances of this species being taken into the alimentary canal of many hosts. If the cyst be destroyed the type of sporocyst is of no importance, and cysts are produced in relatively small numbers, since each represents a fusion of two adult gregarines. It is then essential to the gregarine species that the cyst be able to withstand the unfavorable conditions of the environment in the habitat of the host species until sporocysts may be formed. This is accomplished in some species as *Gregarina blattarum* Siebold of the cockroach and *Gregarina rigida* (Hall) of various species of grasshoppers, by the thick gelatinous envelope surrounding the cyst. This envelope when

dried forms a very tough coat for the cyst. In the case of *Stylocephalus giganteus* it seems that the physiological character which makes the cyst resistant to desiccation, even though dehydration proceed to the distortion of the cyst, is of value to this species in much the same way as the protective envelopes of the first two species. The host of *Stylocephalus giganteus* is active throughout the winter on warm days, so that this species does not have to overcome the loss of host during the winter months as does *Gregarina rigida* in the grasshopper, and *Eleodes* sp. have been taken in December and January containing as many gregarines as beetles of the same species taken in August. These beetles are however distributed through a semi-arid region and the favorite habitats of *Eleodes* spp., under stones or at the bases of shrubby plains plants, are quite dry for the greater part of the year, subjecting the cysts of *Stylocephalus giganteus* even though protected to some extent by the excrement of the host, to considerable drying. As shown by the cysts under observation moisture is essential to the completion of sporocyst formation, since the cysts kept in dry air did not reach the gray and black stages until after they were placed in water. By examination of the meteorological data for eastern Colorado it may be seen that the period of drying to which the cysts here considered were subjected, over four months, exceeds the average droughts in this part of the plains where *Eleodes* spp. are so extensively parasitized.

MAX M. ELLIS

UNIVERSITY OF COLORADO

SEMI-PERMEABLE CAPSULES

DURING a series of experiments to determine the permanency of the fermentative reactions of intestinal bacteria in stored waters, it became necessary to use semi-permeable capsules. A review of the literature failed to show any method which was suitable for our purpose.

As in McCrae's work, gelatine capsules (size 00) are used as a basis for the colloidin capsule. A glass tube about 15 cm. in length is warmed in the gas flame and pressed into the closed end of the empty gelatine capsule. The gelatine plug which inevitably forms in the glass tube must be removed, at this point by means of a wire, otherwise ruptures are liable to occur when the capsules are boiled later.

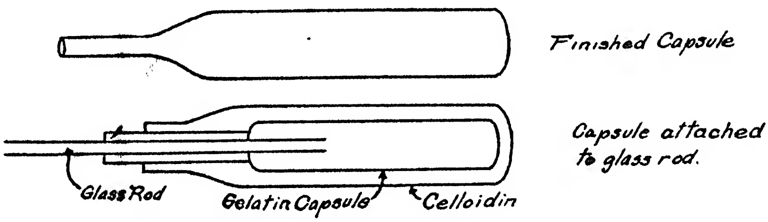

FIG. 1.

The union of the capsule and the glass rod is made airtight by coating the union with a twenty per cent. solution of gelatine by means of a small brush. The layer of gelatine is extended up the glass tube for a distance of about 4 cm. If the two halves of the capsule do not fit tightly, it is advisable to paint them also with the gelatine.

After thoroughly drying, the capsule is dipped into the colloidin solution (colloidin 1 part, ether $1\frac{1}{2}$ parts and alcohol $1\frac{1}{2}$) until a proper thickness is attained, which may be judged by holding the capsule before the light. Experience has shown that at least four dippings are necessary. It was found that the finished capsules were often weak at the point where the halves of the gelatine capsule meet. This point was strengthened by allowing additional colloidin to collect at this place. The

dipped capsules are allowed to dry over night. Premature boiling causes the capsules to swell and burst due to the presence of ether and alcohol in the inner layers of the colloidin. They should not be boiled until they are odorless.

The colloidin capsules are removed from the glass rods by immersing them in boiling water for ten minutes using the glass rods to control the capsules. Leaks may be detected by blowing through the glass rods. If no leaks are detected the capsules can be easily removed from the glass when the gelatin has melted. The capsules generally contain gelatine which may be objectionable in some experiments. This may be removed by filling the capsules with water and boiling them briskly for one half hour. If any of the gelatin remains, the process must be repeated until all has been removed.

The finished capsules may be filled with bouillon, water or any liquid media and sterilized by intermittent sterilization, after which they may be inoculated by platinum needle, pipette or hypodermic syringe. Sealing is accomplished by placing a drop of thick colloidon in the neck of the capsule and allowing it to harden. Leaks may be detected by washing the capsule with sterilized water, after which it is dropped into a tube of sterilized broth and incubated twenty-four hours.

WILLIAM W. BROWNE,
DAVID SOLETSKY
THE COLLEGE OF THE CITY OF NEW YORK

SOCIETIES AND ACADEMIES

THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

THE academy in conjunction with the Wisconsin Archeological Society, the Wisconsin Audubon Society, the Madison Mycological Society, the Wisconsin Mycological Society and the Wisconsin Natural History Society, held its forty-fourth annual meeting at Milwaukee in the Public Museum, when the following program was presented:

First Session Thursday, April 9, at 9 o'clock

"Some Problems Involved in the Cultivation of Medicinal Plants," by Edward Kremers.

"The Garden City Movement in England and Germany," by L. S. Smith. (Illustrated.)

"The Significance of Highway Maintenance in the United States," by L. S. Smith. (By title.)

"A New Indicator for Acids and Alkalis," by A. F. Gilman.

"Origin of the Republican Party," by A. F. Gilman.

"Some Variations Noted in Gall Stones," by G. A. Talbert.

"Geologic Occurrence of Radium Ores," by Rufus Mather Bagg. (Illustrated.)

"The Relation of the Corpus Christi Procession to the Corpus Christi Play in England," by Merle Pierson.

"Some Versions of English Ballads Collected in Milton," by Mabel Maxson.

"William Gager and the Academic Drama at Oxford," by Karl Young. (By title.)

The second session was held on the evening of Thursday, April 9, at 7:30 o'clock, when Professor S. W. Williston, of the University of Chicago, delivered a lecture on "Early Land Animals of North America." This lecture was fully illustrated by many restorations of early extinct animals for the most part made by the lecturer. The lecture was well attended by the public, and was most interesting and valuable.

Third Session, Friday, April 10, at 9:30 o'clock

"The Climate of Madison, Wis. 1. A discussion of the observations of temperature, 1869 to 1913," by Eric R. Miller.

"The Approach to Popular Literature," by Arthur Beatty.

"A Method for Determining Approximate Metabolic Demands of Plants for Soil Water," by H. E. Pulling. (By title.)

"Physiological Changes Causing Black Heart in Potato Tubers," by E. T. Bartholomew. (By title.)

"Further Studies on Wisconsin Tremellineæ," by E. M. Gilbert. (By title.)

"Successful Method for Growing *Clitocybe illudens* and *Armillaria mellea*," by V. H. Young. (By title.)

"The Effect of Lateral Pressure on the Formation and Direction of Growth of Plant Organs," by J. B. Overton. (By title.)

"The Development of Botanical Microtechnique," by Gilbert M. Smith. (By title.)

"The Reaction of Pigment Cells in the Trout to Chemical Stimuli," by John M. Loshinski.

"Fertilization in the Parasitic Copepoda, *Lernæopoda Edwardsii* Olsson," by Nathan Fasten.

"Mutation and Atavism in Plants," by Howland Russell.

"Heat Budgets of European and American Lakes," by E. A. Birge.

"Physiological Age as Determined by Growth of Epiphasis of Wrist Bones," by A. H. Yoder.

"On Habits and Relationship of Some Muscoid Flies," by Sigmund Graenicher.

"Field Record of the Wisconsin Mycological Society for the Season of 1913," by Dr. Lewis Sherman.

"Species of *Clitocybe* in the Region of the Great Lakes," by Edward T. Harper. (By title.)

"Notes on Parasitic Fungi in Wisconsin," by J. J. Davis. (By title.)

"American Water-mites of the Genus *Atractides*," by Ruth Marshall. (By title.)

"The Land Vertebrates of Ridgeway Bog, Wisconsin; their Ecological Succession and Source of Ingression," by Hartley H. T. Jackson. (By title.)

Fourth Session, Friday, April 10, at 2 o'clock

"A Wisconsin Collection of Native Copper Implements," by H. F. Hamilton.

"Indian Earthworks and Sites in Adams County," by H. E. Cole.

"Archeological Researches in Western Wisconsin," by George H. Squier. (By title.)

"The Fond du Lac Cache of Copper Implements," by W. A. Titus. (Read by C. E. Brown.)

"Cairns and Garden Beds in Winnebago County," by George R. Fox.

"The Racial Characteristics of Wisconsin's Population," by Ellis B. Usher.

"Picture Writing by the Esquimaux," by George A. West.

"Archeological Evidences in Door County," by J. P. Schumacher. (By title.)

"Investigation of the Antiquities of Juneau County," by Ira M. Buell. (By title.)

"Archeological Researches in the Northwest Wisconsin Counties," by Charles E. Brown. (By title.)

"Survey of the Antiquities of the Green Lake Region," by Towne L. Miller. (By title.)

"Extension of the Range of Indian Garden Beds and Corn Fields in Wisconsin," by Charles E. Brown.

"Some Problems in Bird Protection," by Victor Kutchin. (By title.)

"Vanishing Horse-sense," by Victor Kutchin. (By title.)

"The Struggle for Game Conservation and Game Breeding Foci," by A. C. Burrill.

"Enforcement of the McLean Law for a Protection of Migratory Birds, etc.," by E. A. Cleasby. (By title.)

Papers 42 and 43 were not read, as Mr. Victor Kutchin was prevented by illness from being present.

Paper 45 was not presented, as Mr. E. A. Cleasby could not leave Iowa at this time because his presence was necessary to provide for the adequate protection of birds. In his absence, Mr. A. C. Burrill read a letter from Mr. Cleasby, gave an explanation of the present situation in Iowa, and presented in some detail the national work for the protection of birds which is being done by Mr. Cleasby.

The academy then adjourned. Next year the annual meeting will be held at Madison, when officers will be elected for the succeeding three years. At that time, the forty-fifth anniversary of the founding of the academy will be observed.

The present officers are:

President, Professor Dana C. Munro.

Secretary and Treasurer, Professor Arthur Beatty.

Librarian, Walter M. Smith.

Arthur Beatty,
Secretary

THE KENTUCKY ACADEMY OF SCIENCE

The Kentucky Academy of Science was organized on May 8, 1914, at a meeting held at State University, Lexington, Ky.

Sixty members were enrolled, and the following were elected as officers: *President*, J. H. Kastle; *Vice-president*, N. F. Smith; *Secretary*, Garnett Ryland; *Treasurer*, W. N. Anderson. Papers and addresses were delivered as follows:

"Some Features of the Ossification of Bones," by J. W. Pryor.

"Work of the U. S. Bureau of Mines," by Van H. Manning, of Washington, D. C.

"The Work of the Experiment Station and the Agricultural Prosperity of Kentucky," by Jos. H. Kastle.

"Science and the State," by Stanley Coulter, of Purdue University.

Garnett Ryland,
Secretary

June 30, 1914.

NEW ORLEANS ACADEMY OF SCIENCES

The regular monthly meeting of the New Orleans Academy of Sciences was held in Stanley Thomas Hall, Tulane University, on Tuesday, May 19. President W. B. Gregory presided with a large attendance of fellows and members. The program of the evening was a paper by Dr. R. B. Bean on "The Time of Eruption and Extent of Decay of the Permanent Teeth in Relation to Race, Sex, Stature, Morphologic Form, School Grade and Development of the Individual." The speaker called attention to the racial differences between Filipino, German and American children in these respects. There was considerable discussion of the paper by Dr. A. G. Friedrichs and other dentists and doctors. After the close of the discussion and adjournment refreshments were served to the fellows and members. The next meeting of the academy will not be held until October.

R. S. Cocks,
Secretary

SCIENCE

FRIDAY, AUGUST 7, 1914

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME ASPECTS OF INDUSTRIAL CHEMISTRY[1]

WHILE I appreciate deeply the distinction of speaking before you on the occasion of the fiftieth anniversary of the Columbia School of Mines, I realize, at the same time, that nobody here present could do better justice to the subject which has been chosen for this lecture, than the beloved master in whose honor the Charles Frederick Chandler Lectureship has been created.

Dr. Chandler, in his long and eminently useful career as a professor and as a public servant, has assisted at the very beginning of some of the most interesting chapters of applied chemistry, here and abroad.

Some of his pupils have become leaders in chemical industry; others have found in his teachings the very conception of new chemical processes which made their names known throughout the whole world.

Industrial chemistry has been defined as "the chemistry of dollars and cents."

This rather cynical definition, in its narrower interpretation, seems to ignore entirely the far-reaching economic and civilizing influences which have been brought to life through the applications of science; it fails to do justice to the fact that the whole fabric of modern civilization becomes each day more and ever more interwoven with the endless ramifications of applied chemistry.

The earlier effects of this influence do not date back much beyond one hundred and odd years. They became distinctly evident during the first French Republic, in-

[1] An address given at Columbia University to inaugurate the Charles F. Chandler lectureship.

creased under Napoleon, gradually spread to neighboring countries, and then reaching out farther, their influence is now obvious throughout the whole world.

France, during the revolution, scattered to the winds old traditions and conventionalities, in culture as well as in politics. Until then, she had mainly impressed the world by the barbaric, wasteful splendor of her opulent kings, at whose courts the devotees of science received scant attention in comparison to the more ornamental artists and belles-lettrists, who were petted and rewarded alongside of the all-important men of the sword.

In fact, as far as the culture of science was concerned, the Netherlands, Germany and Italy, and more particularly, England, were head and shoulders above the France of "le Roi Soleil."

The struggles of the new régime put France in the awkward position of the legendary beaver which "had to climb a tree."

If for no other reason, she needed scientists to help her in her wars against the rulers of other European nations. She needed them just as much for repairing her crippled finances and her badly disturbed industries which were dependent upon natural products imported until then, but of which the supply had suddenly been cut off by the so-called Continental Blockade. Money-prizes and other inducements had been offered for stimulating the development of chemical processes, and—what is more significant—patent laws were promulgated so as to foster invention.

Nicolas Leblanc's method for the manufacture of soda to replace the imported alkalis, Berthollet's method for bleaching with chlorine, the beet-sugar industry, to replace cane sugar imported from the colonies, and several other processes, were proposed.

All these chemical processes found themselves soon lifted from the hands of the secretive alchemist or the timid pharmacist to the rank of real manufacturing methods. Industrial chemistry had begun its lusty career.

First successes stimulated new endeavors and small wonder is it that France, with these favorable conditions at hand, for a while at least, entered into the most glorious period of that part of her history which relates to the development of chemistry, and the arts dependent thereon.

It is difficult to imagine that, at that time, Germany, which now occupies such an enviable position in chemistry, was so far behind that even in 1822, when Liebig wanted to study chemistry at the best schools, he had to leave his own country, and turn to Gay-Lussac, Thénard and Dulong in Paris.

But the British were not slow to avail themselves of the new opportunities in chemical manufacturing so clearly indicated by the first successes of the French. Their linen bleacheries in Scotland and England soon used an improved method for bleaching with chloride of lime, developed by Tennant, which brought along the manufacture of other chemicals relating thereto, like sulphuric acid and soda.

The chemical reactions involved in all these processes are relatively simple, and after they were once well understood, it required mainly resourceful engineering and good commercial abilities to build up successfully the industries based thereon.

From this epoch on dates the beginning of the development of that important industry of heavy chemicals in which the British led the world for almost a century.

In the same way, England had become the leader in another important branch of chemical industry—the manufacture of coal-gas.

The Germans were soon to make up for lost time.[8] Those same German universities which, when Liebig was a young man, were so poorly equipped for the study of chemistry, were now enthusiastically at work on research along the newer developments of the physical sciences, and, before long, the former pupils of France, in their turn, became teachers of the world.

Liebig had inaugurated for the chemical students working under him his system of research laboratories; however modest these laboratories may have been at that time, they carried bodily the study of chemistry from pedagogic boresomeness into a captivating cross-examination of nature.

And it seemed as if nature had been waiting impatiently to impart some of her secrets to the children of men, who for so many generations had tried to settle truth and knowledge by words and oratory and by brilliant displays of metaphysical controversies.

Indeed, at that time, a few kitchen tables, some clumsy glass-ware, a charcoal furnace or two, some pots and pans, and a modest balance were all that was needed to make nature give her answers.

These modest paraphernalia, eloquent by their very simplicity, brought forth rapidly succeeding discoveries. One of them was truly sensational: Liebig and Wöhler succeeded in accomplishing the direct synthesis of urea; thinking men began to realize the far-reaching import of this revolutionary discovery whereby a purely organic substance had been created in the laboratory by starting exclusively from inorganic materials. This result upset all respected doctrines that organic substances are of a special enigmatic constitution, altogether different from inorganic or mineral compounds, and that they only could be built up by the agency of the so-called "vital force"—whatever that might mean.

Research in organic chemistry became more and more fascinating; all available organic substances were being investigated one after another by restless experimentalists.

Coal-tar, heretofore a troublesome by-product of gas manufacture, notwithstanding its uninviting, ill-smelling, black sticky appearance, did not escape the general inquisitive tendency; some of its constituents, like benzol or others, were isolated and studied.

Under the brilliant leadership of Kékulé, a successful attempt was made to correlate the rapidly increasing new experimental observations in organic chemistry into a new theory which would try to explain all the numerous facts; a theory which became the sign-post to the roads of further achievements.

The discovery of quickly succeeding processes for making from coal-tar derivatives numerous artificial dyes, rivaling, if not surpassing, the most brilliant colors of nature, made the group of bold investigators still bolder. Research in organic chemistry began to find rapid rewards; entirely new and successful industries based on purely scientific data were springing up in England and France, as well as in Germany.

Some wide-awake leaders of these new enterprises, more particularly in Germany, soon learned that they were never hampered by too much knowledge, but that, on the contrary, they were almost continuously handicapped in their impatient onward march by insufficient knowledge, or by misleading conceptions, if not by incorrect published facts.

This is precisely where the study of organic chemistry received its greatest stimulating influence and soon put Ger-

many in this branch of science, ahead of all other nations.

Money and effort had to be spent freely for further research. The best scholars in chemistry were called into action. Some men, who were preparing themselves to become professors, were induced to take a leading part as directors in one or another of the new chemical enterprises. Others, who refused to forsake their teachers' career, were retained as advisers or guides, and, in several instances, the honor of being the discoverers of new processes, or a new dye, was made more substantial by financial rewards. The modest German university professor, who heretofore had lived within a rather narrow academic sphere, went through a process of evolution, where the rapidly growing chemical industry made him realize his latent powers and greater importance, and broadened his influence far beyond the confines of his lecture-room. Even if he were altruistic enough to remain indifferent to fame or money, he felt stimulated by the very thought that he was helping, in a direct manner, to build up the nation and the world through the immediate application of the principles of science.

In the beginning, science did all the giving and chemical industry got most of the rewards; but soon the rôles began to change to the point where frequently they became entirely inverted. The universities did not furnish knowledge fast enough to keep pace with the requirements of the rapidly developing new industries. Modern research laboratories were organized by some large chemical factories on a scale never conceived before, with a lavishness which made the best equipped university laboratory appear like a timid attempt. Germany, so long behind France and England, had become the recognized leader in organic manufacturing processes, and developed a new industrial chemistry based more on the thorough knowledge of organic chemistry than on engineering skill.

In this relation, it is worth while to point out that the early organic industrial chemistry, through which Germany was soon to become so important, at first counted its output not in tons, but in pounds—not in size nor in quantity, but in variety and quality.

Now let us see how Germany won her spurs in chemical engineering as well:

At the beginning, the manufacturing problems in organic chemistry involved few, if any, serious engineering difficulties, but required, most of all, a sound theoretical knowledge of the subject; this put a premium on the scientist, and could afford, for awhile at least, to ignore the engineer. But when growing developments began to claim the help of good engineers, there was no difficulty whatsoever in supplying them, nor in making them cooperate with the scientists. In fact, since then, Germany has solved, just as successfully, some of the most extraordinary chemical engineering problems ever undertaken, although the development of such processes was entered upon at first from the purely scientific side.

In almost every case, it was only after the underlying scientific facts had been well established, that any attempt was made to develop them commercially.

Healthy commercial development of new scientific processes does not build its hope of success upon the cooperation of that class of "promoters" which are always eager to find any available pretext for making "quick money," and whose scientific ignorance contributes conveniently to their comfort by not interfering too much with their self-assurance and their voluble assertions. The history of most of the successful recent chemical processes abounds in examples where, even after the under-

lying principles were well established, long and costly, preparatory team-work had to be undertaken; where foremost scientists, as well as engineers of great ability, had to combine their knowledge, their skill, their perseverance, with the support of large chemical companies, who, in their turn, could rely on the financial backing of strong banking concerns, well advised by tried expert specialists.

History does not record how many processes thus submitted to careful study were rejected because, on close examination, they were found to possess some hopeless shortcomings. In this way, numerous fruitless efforts and financial losses were averted, where less carefully accumulated knowledge might have induced less scrupulous promoters to secure money for plausible but ill-advised enterprises.

In the history of the manufacture of artificial dyes, no chapter gives a more striking instances of long, assiduous and expensive preliminary work of the highest order than the development of the industrial synthesis of indigo. Here was a substance of enormous consumption which, until then, had been obtained from the tropics as a natural product of agriculture.

Professor von Baeyer and his pupils, by long and marvelously clever laboratory work, had succeeded in unraveling the chemical constitution of this indigo dye, and had finally indicated some possible methods of synthesis. Notwithstanding all this, it took the Badische Aniline & Soda Fabrik about twenty years of patient research work, carried out by a group of eminent chemists and engineers, before a satisfactory method was devised by which the artificial product could compete in price and in quality with natural indigo.

Germany, with her well-administered and easily enforcible patent laws, has added, through this very agency, a most vital inducement for pioneer work in chemical industries. Who otherwise would dare to take the risk of all the expenses connected with this class of creative work? Moreover, who would be induced to publish the result of his discoveries far and wide throughout the whole world in that steadily flowing stream of patent literature, which, much sooner than any text-books or periodicals, enables one worker to be benefited and to be inspired by the publication of the latest work of others?

The development of some problems of industrial chemistry has enlisted the brilliant collaboration of men of so many different nationalities that the final success could not, with any measure of justice, be ascribed exclusively to one single race or nation; this is best illustrated by the invention of the different methods for the fixation of nitrogen from the air.

This extraordinary achievement, although scarcely a few years old, seems already an ordinary link in the chain of common, current events of our busy life; and yet, the facts connected with this recent conquest reveal a modern tale of great deeds of the race—an epos of applied science.

Its story began the day when chemistry taught us how indispensable are the nitrogeneous substances for the growth of all living beings.

Generally speaking, the most expensive food-stuffs are precisely those which contain most nitrogen; for the simple reason that there is, and always has been, at some time or another, a shortage of nitrogeneous foods in the world. Agriculture furnishes us these proteid- or nitrogen-containing bodies, whether we eat them directly as vegetable products, or indirectly as animals which have assimilated the proteids from plants. It so happens, however, that by our ill-balanced methods of agriculture, we take nitrogen from the soil much faster

than it is supplied to the soil through natural agencies. We have tried to remedy this discrepancy by enriching the soil with manure or other fertilizers, but this has been found totally insufficient, especially with our methods of intensive culture—our fields want more nitrogen. So agriculture has been looking anxiously around to find new sources of nitrogen fertilizer. For a short time, an excellent supply was found in the guano deposits of Peru; but this material was used up so eagerly that the supply lasted only a very few years. In the meantime, the ammonium salts recovered from the by-products of the gas-works have come into steady use as nitrogen fertilizer. But, here again, the supply is entirely insufficient, and during the later period our main reliance has been placed on the natural beds of sodium nitrate, which are found in the desert regions of Chile. This has been, of late, our principal source of nitrogen for agriculture, as well as for the many industries which require saltpeter or nitric acid.

In 1898, Sir William Crookes, in his memorable presidential address before the British Association for the Advancement of Science, called our attention to the threatening fact that, at the increasing rate of consumption, the nitrate beds of Chile would be exhausted before the middle of this century. Here was a warning—an alarm call—raised to the human race by one of the deepest scientific thinkers of our generation. It meant no more nor less than that before long our race would be confronted with nitrogen starvation. In a given country, all other conditions being equal, the abundance or the lack of nitrogen available for nutrition is a paramount factor in the degree of general welfare, or of physical decadence. The less nitrogen there is available as food-stuffs, the nearer the population is to starvation. The great famines in such nitrogen-deficient countries as India and China and Russia are sad examples of nitrogen starvation.

And yet, nitrogen, as such, is so abundant in nature that it constitutes four fifths of the air we breathe. Every square mile of our atmosphere contains nitrogen enough to satisfy our total present consumption for over half a century. However, this nitrogen is unavailable as long as we do not find means to make it enter into some suitable chemical combination. Moreover, nitrogen was generally considered inactive, and inert, because it does not enter readily in chemical combination.

William Crookes's disquieting message of rapidly approaching nitrogen starvation did not cause much worry to politicians—they seldom look so far ahead into the future. But, to the men of science, it rang like a reproach to the human race. Here, then, we were in possession of an inexhaustible store of nitrogen in the air, and yet, unless we found some practical means for tying some of it into a suitable chemical combination, we should soon be in a position similar to that of a shipwrecked sailor, drifting around on an immense ocean of brine, and yet slowly dying for lack of drinking water.

As a guiding beacon, there was, however, that simple experiment, carried out in a little glass tube, as far back as 1785, by both Cavendish and Priestley, which showed that if electric sparks were passed through air, the oxygen thereof was able to burn some of the nitrogen and to engender nitrous vapors.

This seemingly unimportant laboratory curiosity, so long dormant in the text-books, was made a starting point by Charles S. Bradley and D. R. Lovejoy, in Niagara Falls, for creating the first industrial apparatus for converting the nitrogen of the

air into nitric acid by means of the electric arc.

As early as 1902, they published their results as well as the details of their apparatus. Although they operated only one full-sized unit, they demonstrated conclusively that nitric acid could thus be produced from the air in unlimited quantities. We shall examine later the reasons why this pioneer enterprise did not prove a commercial success; but to these two American inventors belongs, undoubtedly, the credit of having furnished the first answer to the distress call of Sir William Crookes.

In the meantime, many other investigators were at work at the same problem, and soon from Norway's abundant waterfalls came the news that Birkeland and Eyde had solved successfully, and on a commercial scale, the same problem by a differently constructed apparatus. The Germans, too, were working on the same subject, and we heard that Schoenherr, also Pauling, had evolved still other methods, all, however, based on the Cavendish-Priestley principle of oxidation of nitrogen. In Norway alone the artificial salpeter factories use now, day and night, over 200,000 electrical horse-power, which will soon be doubled; while a further addition is contemplated which will bring the volume of electric current consumed to about 500,000 horse-power. The capital invested at present in these works amounts to $27,000,000.

Frank and Caro, in Germany, succeeded in creating another profitable industrial process whereby nitrogen could be fixed by carbide of calcium, which converts it into calcium cyanamide, an excellent fertilizer by itself. By the action of steam on cyanamide, ammonia is produced, or it can be made the starting point of the manufacture of cyanides, so profusely used for the treatment of gold and silver ores.

Although the synthetic nitrates have found a field of their own, their utilization for fertilizers is smaller than that of the cyanamide; and the latter industry represents, to-day, an investment of about $30,000,000, with three factories in Germany, two in Norway, two in Sweden, one in France, one in Switzerland, two in Italy, one in Austria, one in Japan, one in Canada, but not any in the United States. The total output of cyanamide is valued at $15,000,000 yearly and employs 200,000 horse-power, and preparations are made at almost every existing plant for further extensions. An English company is contemplating the application of 1,000,000 horse-power to the production of cyanamide and its derivatives, 600,000 of which have been secured in Norway and 400,000 in Iceland.

But still other processes are being developed, based on the fact that certain metals or metalloids can absorb nitrogen, and can thus be converted into nitrides; the latter can either be used directly as fertilizers or they can be made to produce ammonia under suitable treatment.

The most important of these nitride processes seems to be that of Serpek, who, in his experimental factory at Niedermorschweiler, succeeded in obtaining aluminum nitride in almost theoretical quantities, with the use of an amount of electrical energy eight times less than that needed for the Birkeland-Eyde process and one half less than for the cyanamide process, the results being calculated for equal weights of "fixed" nitrogen.

A French company has taken up the commercial application of this process which can furnish, besides ammonia, pure alumina for the manufacture of aluminum metal.

An exceptionally ingenious process for the direct synthesis of ammonia, by the

direct union of hydrogen with nitrogen, has been developed by Haber in conjunction with the chemists and engineers of the Badische Aniline & Soda Fabrik.

The process has the advantage that it is not, like the other nitrogen-fixation processes, paramountly dependent upon cheap power; for this reason, if for no other, it seems to be destined to a more ready application. The fact that the group of the three German chemical companies which control the process have sold out their former holdings in the Norwegian enterprises to a Norwegian-French group, and are now devoting their energies to the commercial installation of the Haber process, has quite some significance as to expectation for the future.

The question naturally arises: Will there be an over-production and will these different rival processes not kill each other in slaughtering prices beyond remunerative production?

As to over-production, we should bear in mind that nitrogen fertilizers are already used at the rate of about $200,000,000 worth a year, and that any decrease in price, and, more particularly, better education in farming, will probably lead to an enormously increased consumption. It is worth mentioning here that in 1825, the first shipload of Chile saltpeter, which was sent to Europe, could find no buyer, and was finally thrown into the sea as useless material.

Then again, processes for nitric acid and processes for ammonia, instead of interfering, are supplementary to each other, because the world needs ammonia and ammonium salts, as well as nitric acid or nitrates.

It should be pointed out also, that, ultimately, the production of ammonium nitrate may prove the most desirable method so as to minimize freight; for this salt contains much more nitrogen to the ton than is the case with the more bulky calcium-salt, under which form synthetic nitrates are now put into the market.

Before leaving this subject, let us examine why Bradley and Lovejoy's efforts came to a standstill where others succeeded.

First of all, the cost of power at Niagara Falls is three to five times higher than in Norway, and although at the time this was not strictly prohibitive for the manufacture of nitric acid, it was entirely beyond hope for the production of fertilizers. The relatively high cost of power in our country is the reason why the cyanamide enterprise had to locate on the Canadian side of Niagara Falls, and why, up till now, outside of an experimental plant in the South (a 4,000 horse-power installation in North Carolina, using the Pauling process), the whole United States has not a single synthetic nitrogen fertilizer works.

The yields of the Bradley-Lovejoy apparatus were rather good. They succeeded in converting as much as two and one half per cent. of the air, which is somewhat better than their successors are able to accomplish.

But their units, 12 kilowatts, were very much smaller than the 1,000 to 3,000 kilowatts now used in Norway; they were also more delicate to handle, all of which made installation and operation considerably more expensive.

However this was the natural phase through which any pioneer industrial development has to go, and it is more than probable that in the natural order of events, these imperfections would have been eliminated.

But the killing stroke came when financial support was suddenly withdrawn.

In the successful solution of similar industrial problems, the originators in Europe were not only backed by scientif-

ically well-advised bankers, but they were helped to the rapid solution of all the side problems by a group of specially selected scientific collaborators, as well as by all the resourcefulness of well-established chemical enterprises.

That such conditions are possible in the United States has been demonstrated by the splendid team-work which led to the development of the modern Tungsten lamp in the research laboratories of the General Electric Company, and to the development of the Tesla polyphase motor, by the group of engineers of the Westinghouse Company.

True, there are endless subjects of research and development which can be brought to success by the efforts of single independent inventors, but there are some problems of applied science which are so vast, so much surrounded with ramifying difficulties, that no one man, nor two men, however exceptional, can either furnish the brains or the money necessary for leading to success within a reasonable time. For such special problems, the rapid cooperation of numerous experts and the financial resources of large establishments are indispensable.

All these examples of the struggle for efficiency and improvement demonstrate why, in industrial chemistry, the question of *dollars and cents* has to be taken very much into consideration.

From this standpoint at least, the "dollars and cents" argument can be interpreted as a symptom of industrial efficiency, and thus, the definition sounds no longer as a reproach. With some allowable degree of accuracy, it formulates one of the economic aspects of any acceptable industrial chemical process.

Indeed, barring special conditions, as, for instance, incompetent or reckless management, unfair competition, monopolies, or other artificial privileges, the money success of a chemical process is the cash plebiscite of approval of the consumers. It is bound, after a time at least, to weed out the inefficient methods.

Some chemists, who have little or no experience with industrial enterprises, are too much over-inclined to judge a chemical process exclusively from the standpoint of the chemical reactions involved therein, without sufficient regard to engineering difficulties, financial requirements, labor problems, market and trade conditions, rapid development of the art involving frequent disturbing improvements in methods and expensive changes in equipment, advantages or disadvantages of the location of the plant, and other conditions so numerous and variable that many of them can hardly be foreseen even by men of experience.

And yet, these seemingly secondary considerations most of the time become the deciding factor of success or failure of an otherwise well-conceived chemical process.

The cost of transportation alone will, frequently, decide whether a certain chemical process is economically possible or not. For instance, the big Washoe Smelter, in Montana, wastes enough sulphuric-dioxide gas to make daily 1,800 tons of sulphuric acid, but that smelter is too far distant from any possible market for such a quantity of otherwise valuable material.

Another example of the kind is found in the natural deposits of soda or soda lakes in California. One of these soda lakes contains from thirty to forty-two million tons of soda. Here is a natural source of supply which would be ample to satisfy the world's demand for many years to come. Similar deposits exist in other parts of the world, but the cost of transportation to a sufficiently large and profitable market is so exorbitant that, in the meantime, it is cheaper to erect at more convenient points

expensive chemical works in which soda is made chemically and from where the market can be supplied more profitably.

In addition, we can cite the artificial nitrate processes in Norway, which, notwithstanding their low efficiency and expensive installation, can furnish nitrate in competition with the natural nitrate beds of Chile, because the latter are hampered by the cost of extraction from the soil where fuel for crystallization is expensive, in addition to the considerable cost of freight.

But there is no better example illustrating the far-reaching effect of seemingly secondary conditions upon the success of a chemical process than the history of the Leblanc soda process.

This famous process was the forerunner of chemical industry. For almost a century it dominated the enormous group of industries of heavy chemicals, so expressively called by the French "La Grande Industrie Chimique," and now we are witnesses of the lingering death agonies of this chemical colossus. Through the Leblanc process, large fortunes have been made and lost; but even after its death, it will leave a treasure of information to science and chemical engineering, the value of which can hardly be overestimated.

Here, then, is a very well worked-out process, admirably studied in all its details, which, in its heroic struggle for existence, has drawn upon every conceivable resource of ingenuity furnished by the most learned chemists and the most skilful engineers, who succeeded in bringing it to an extraordinary degree of perfection, and which, nevertheless, has to succumb before inexorable, although seemingly secondary, conditions.

Strange to say, its competitor, the Solvay process, entered into the arena after a succession of failures. When Solvay, as a young man, took up this process, he was, himself, totally ignorant of the fact that no less than about a dozen able chemists had invented and reinvented the very reaction on which he had pinned his faith; that, furthermore, some had tried it on a commercial scale, and had, in every instance, encountered failure. At that time, all this must, undoubtedly, have been to young Solvay a revelation sufficient to dishearten almost anybody. But he had one predominant thought to which he clung as a last hope of success, and which would probably have escaped most chemists; he reasoned that, in this process, he starts from two watery solutions, which, when brought together, precipitate a dry product, bicarbonate of soda; in the Leblanc process, the raw materials must be melted together, with the use of expensive fuel, after which the mass is dissolved in water, losing all these valuable heat units, while more heat has again to be applied to evaporate to dryness.

After all, most of the weakness of the Leblanc process resides in the greater consumption of fuel. But the cost of fuel, here again, is determined by freight rates. This is so true that we find that the last few Leblanc works which manage to keep alive are exactly those which are situated near unusually favorable shipping points, where they can obtain cheap fuel, as well as cheap raw materials, and whence they can most advantageously reach certain profitable markets.

But another tremendous handicap of the Leblanc process is that it gives as one of its by-products, hydrochloric acid. Profitable use for this acid, as such, can be found only to a limited extent. It is true that hydrochloric acid could be used in much larger quantities for many purposes where sulphuric acid is used now, but it has, against sulphuric acid, a great freight disadvantage. In its commercially available

condition, it is an aqueous solution, containing only about one third of real acid, so that the transportation of one ton of acid practically involves the extra cost of freight of about two tons of water. Furthermore, the transportation of hydrochloric acid in anything but glass carboys involves very difficult problems in itself, so that the market for hydrochloric acid remains always within a relatively small zone from its point of production. However, for awhile at least, an outlet for this hydrochloric acid was found by converting it into a dry material which can easily be transported; namely, chloride of lime or bleaching-powder.

The amount of bleaching-powder consumed in the world practically dictated the limited extent to which the Leblanc process could be profitably worked in competition with the Solvay process. But even this outlet has been blocked during these later years by the advent of the electrolytic alkali processes, which have sprung up successfully in several countries, and which give as a cheap by-product, chlorine, which is directly converted into chloride of lime.

To-day, any process which involves the production of large quantities of hydrochloric acid, beyond what the market can absorb as such, or as derivatives thereof, becomes a positive detriment, and foretells failure of the process. Even if we could afford to lose all the acid, the disposal of large quantities thereof conflicts immediately with laws and ordinances relative to the pollution of the atmosphere or streams, or the rights of neighbors, and occasions expensive damage suits.

Whatever is said about hydrochloric acid applies to some extent to chlorine, produced in the electrolytic manufacture of caustic soda. Here again, the development of the latter industry is limited, primarily, by the amount of chlorine which the market, as such, or as chlorinated products, can absorb.

At any rate, chlorine can be produced so much cheaper by electrolytic caustic alkali processes than formerly, and in the meantime the market price of chloride of lime has already been cut about in half.

In as far as the rather young electrolytic alkali industry has taken a considerable development in the United States, let us examine it somewhat nearer.

At present, the world's production of chloride of lime approximates about half a million tons.

We used to import all our chloride of lime from Europe, until about fifteen years ago, when the first successful electrolytic alkali works were started at Niagara Falls. That ingenious mercury cell of Hamilton Y. Castner—a pupil of Professor Chandler and one of the illustrious sons of the Columbia School of Mines—was first used, and his process still furnishes a large part of all the electrolytic caustic soda and chlorine manufactured here and abroad.

At present, about 30,000 electrical horsepower are employed uninterruptedly for the different processes used in the United States, and our home production has increased to the point where, instead of importing chloride of lime, we shall soon be compelled to export our surplus production.

It looks now as if, for the moment at least, any sudden considerable increase in the production of chloride of lime would lead to over-production until new channels of consumption of chloride of lime or other chlorine products can be found.

However, new uses for chlorine are being found every day. The very fact that commercial hydrochloric acid of exceptional purity is now being manufactured in Niagara Falls by starting from chlorine, indicates clearly that conditions are being reversed; no longer than a few years ago,

when chlorine was manufactured exclusively by means of hydrochloric acid, this would have sounded like a paradox.

The consumption of chlorine for the preparation of organic chlorination products utilized in the dye-stuff industry, is also increasing continually, and its use for the manufacture of tetrachloride of carbon and so-called acetylen chlorination products, has reached quite some importance.

There is probably a much overlooked but wider opening for chlorinated solvents in the fact that ethylen-gas can be prepared now at considerably lower cost than acetylen, and that ethylen-chloride, or the old known "Dutch Liquid," is an unusually good solvent. It has, furthermore, the great advantage that its specific gravity is not too high, and its boiling point, too, is about the right temperature. It ought to be possible to make it at such a low price that it would find endless applications where the use of other chlorination solvents has thus far been impossible.

The chlorination of ores for certain metallurgical processes may eventually open a still larger field of consumption for chlorine.

In the meantime, liquified chlorine gas, obtained by great compression, or by intense refrigeration, has become an important article of commerce, which can be transported in strong steel cylinders. Its main utilization resides in the manufacture of tin chloride by the Goldschmidt process for reclaiming tin-scrap. It is finding, also, increased applications as a bleaching agent and for the purification of drinking water, as well as for the manufacture of various chlorination products.

Its great handicap for rapid introduction is again the question of freight, where heavy and expensive containers become indispensable.

In most cases the transportation problem of chlorine is solved more economically by handling it as chloride of lime, which, after all, represents chlorine or oxygen in solid form, easily transportable.

It would seem as if the freight difficulty could easily be eliminated by producing the chlorine right at the spot of consumption. But this is not always so simple as it may appear. To begin with, the cost of an efficient plant for any electrolytic operation is always unusually high as compared to other chemical equipments. Then, also, small electrolytic alkali plants are not profitable to operate. Furthermore, the conditions for producing cheap chlorine depend on many different factors, which all have to coordinate advantageously; for instance, cheap power, cheap fuel and cheap raw materials are essential, while, at the same time, a profitable outlet must be found for the caustic soda.

Lately, there has been a considerable reduction of the market price of caustic soda; all this may have for effect that the less efficient electrolytic processes will gradually be eliminated; although this may not necessarily be the case for smaller plants which do not compete in the open market, but consume their own output for some special purpose.

Several distinct types of electrolytic cells are now in successful use, but experience seems to demonstrate that the so-called diaphragm cells are cheapest to construct and to operate, provided, however, no exception be taken to the fact that the caustic soda obtained from diaphragm cells always contains some sodium chloride, usually varying from two to three per cent., which it is not practical to eliminate, but which for almost all purposes does not interfere in the least with its commercial use.

Mercury cells give a much purer caustic soda, and this may, in some cases, compen-

sate for their more expensive equipment and operation. Moreover, there are some purposes where the initial caustic solution of rather high concentration, produced directly in these cells, can be used as it is without further treatment, thus obviating further concentration and cost of fuel.

The expenses for evaporation and elimination of salt from the raw caustic solutions increase to an exaggerated extent with some types of diaphragm cells, which produce only very weak caustic liquors. This is also the case with the so-called "gravity cell," sometimes called the "bell type," or "Aussig type," of cell. But these gravity cells have the merit of dispensing with the delicate and expensive problem of diaphragms. On the other hand, their units are very small, and, on this account, they necessitate a rather complicated installation, occupying an unusually large floor space and expensive buildings.

The general tendency is now toward cells which can be used in very large units, which can be housed economically, and of which the general cost of maintenance and renewal is small; some of the modern types of diaphragm cells are now successfully operating with 3,000 to 5,000 amperes per cell.

As to the possible future improvements in electrolytic alkali cells, we should mention that in some types the current efficiencies have practically reached their maximum, and average ampere efficiencies as high as 95 to 97 per cent. have been obtained in continuous practise. The main difficulty is to reinforce these favorable results by the use of lower voltage, without making the units unnecessarily bulky, or expensive in construction, or in maintenance, all factors which soon outweigh any intended saving of electric current.

Here, more than in any other branch of chemical engineering, it is easy enough to determine how "good" a cell is on a limited trial, but it takes expensive, long continuous use on a full commercial scale, running uninterruptedly day and night for years, to find out how "bad" it is for real commercial practise.

In relation to the electrolytic alkali industry, a great mistake is frequently committed by considering the question of power as paramount; true enough, cheap power is very important, almost essential, but certainly it is not everything. There have been cases where it was found much cheaper in the end to pay almost double for electric current in a certain locality, than in another site not far distant from the first, for the simple reason that the cheaper power supply was hampered by frequent interruptions and expensive disturbances, which more than offset any possible saving in cost of power.

In further corroboration, it is well known that some of the most successful electrolytic soda manufacturers have found it to their advantage to sacrifice power by running their cells at decidedly higher voltage than is strictly necessary—which simply means consuming more power—and this in order to be able to use higher current densities, thereby increasing considerably the output of the same size units, and thus economizing on the general cost of plant operation. Here is one of the ever recurring instances in chemical manufacturing where it becomes more advantageous to sacrifice apparent theoretical efficiency in favor of industrial expediency.

All this does not diminish the fact that the larger electrochemical industries can only thrive where cheap power is available.

Modern progress of electrical engineering has given us the means to utilize so-called natural powers; until now, however, we have only availed ourselves of the water-power developed from rivers, lakes

and waterfalls. As far as large electric power generation is concerned, the use of the wind, or the tide, or the heat of the sun, represents, up till now, nothing much beyond a mere hope of future possibilities.

In the meantime, it so happens, unfortunately, that many of the most abundant water-powers of the world are situated in places of difficult access, far removed from the zone of possible utilization.

But, precisely on this account, it would appear, at first sight, as if the United States, with some of her big water-powers situated nearer to active centers of consumption, would be in an exceptionally favorable condition for the development of electrochemical industries. On closer examination, we find, however, that the cost of water-power, as sold to manufacturers, is, in general, much higher than might be expected; at any rate, it is considerably more expensive than the cost of electric power utilized in the Norway nitrate enterprises.

This is principally due to the fact that in the United States, water-power, before it is utilized by the electrolytic manufacturer, has already to pay one, two and sometimes three, profits, to as many intermediate interests, which act as so many middlemen between the original water-power and the consumer. Only in such instances as in Norway, where the electrochemical enterprise and the development of the water-power are practically in the same hands, can electric current be calculated at its real cheapest cost.

Neither should the fact be overlooked that the best of our water-powers in the east are situated rather far inland. Although this does not matter much for the home market, it puts us at a decided disadvantage for the exportation of manufactured goods, in comparison again with Norway, where the electrolytic plants are situated quite close to a good sea-harbor open in all seasons.

Some electrochemical enterprises require cheap fuel just as much as cheap power; and, on this account, it has proved sometimes more advantageous to dispense entirely with water-power by generating gas for fuel as well as for power from cheap coal or still cheaper peat.

At present most of our ways of using coal are still cumbersome and wasteful, although several efficient methods have been developed which some day will probably be used almost exclusively, principally in such places where lower grades of cheap coal are obtainable.

I refer here particularly to the valuable pioneer work of that great industrial chemist, Mond, on cheap water-gas production, by the use of limited amount of air in conjunction with water vapor.

More recently, this process has been extended by Caro, Frank and others, to the direct conversion of undried peat into fuel-gas.

By the use of these processes, peat or lower grades of coal, totally unsuitable for other purposes, containing, in some instances, as much as 60 to 70 per cent. of incombustible constituents, can be used to good advantage in the production of fuel for power generation.

Whether Mond-gas will ever be found advantageous for distribution to long distances, is questionable, because its heating value per cubic foot is rather less than that of ordinary water-gas, but this does not interfere with its efficient use in internal combustion engines.

In general, our methods for producing or utilizing gas in our cities do scant justice to the extended opportunities indicated by our newer knowledge.

Good fuel-gas could be manufactured and distributed to the individual household

consumer at considerably cheaper rates, if it were not for antiquated municipal specifications, which keep on prescribing photometric tests instead of insisting on standards of fuel value, which makes the cost of production unnecessarily high, and disregards the fact that for lighting, the Welsbach mantle has rendered obsolete the use of highly carbureted gas as a bare flame. But for those unfortunate specifications, cheap fuel-gas might be produced at some advantageous central point, where very cheap coal is available; such heating gas could be distributed to every house and every factory, where it could be used cleanly and advantageously, like natural gas, doing away at once with the black coal smoke nuisance, which now practically compels a city like New York to use nothing but the more expensive grades of anthracite coal. It would eliminate, at the same time, all the bother and expense caused through the clumsy and expensive methods of transportation and handling of coal and ashes; it would relieve us from many unnecessary middlemen which now exist between coal and its final consumer.

The newer large-sized internal combustion engines are introducing increasing opportunities for new centers of power production where waste gas of blast-furnaces or coke-ovens, or where deposits of inferior coal or peat, are available.

If such centers are situated near tidewater, this may render them still more advantageous for some electrochemical industries, which, until now, were compelled to locate near some inland waterpowers.

Nor should we overlook the fact that the newer methods for the production of cheap fuel-gas offer excellent opportunities for an increased production of valuable tar by-products, and more particularly of ammonium salts; the latter would help to a not inconsiderable extent in furnishing more nitrogen fertilizer.

It is somewhat remarkable that a greater effort has already been made to start the industrial synthesis of nitrogen products than to economize all these hitherto wasted sources of ammonia.

In fact, science indicates still other ways, somewhat of a more radical nature, for correcting the nitrogen deficiencies in relation to our food supply.

Indeed, if we will look at this matter from a much broader standpoint, we may find that, after all, the shortage of nitrogen in the world is attributable to a large extent to our rather one-sided system of agriculture. We do not sufficiently take advantage of the fact that certain plants, for instance those of the group of Leguminosæ, have the valuable property of easily assimilating nitrogen from the air, without the necessity of nitrogen fertilizers. In this way, the culture of certain Leguminosæ can insure enough nitrogen for the soil, so that, in rotation with nitrogen consuming crops, like wheat, we could dispense with the necessity of supplying any artificial nitrogen fertilizers.

The present nitrogen deficiency is influenced further by two other causes:

The first cause is our unnecessary exaggerated meat diet, in which we try to find our proteid requirements, and which compels us to raise so many cattle, while the amount of land which feeds one head of cattle could furnish, if properly cultivated, abundant vegetable food for a family of five.

The second cause is our insufficient knowledge of the way to grow and prepare for human food just those vegetables which are richest in proteids. Unfortunately, it so happens that exactly such plants as, for instance, the soy-bean are not by any means easily rendered palatable and digestible;

while any savage can eat raw meat, or can readily cook, boil or roast it for consumption.

On this subject, we can learn much from some Eastern people, like the Japanese, who have become experts in the art of preparing a variety of agreeable food products from that refractory soy-bean, which contains such an astonishingly large amount of nutritious proteids, and which, long ago, became for Japan a wholesome, staple article of diet.

But, on this subject, the Western races have not yet progressed much beyond the point of preparing cattle-feed and paint oil from the soy-bean, although the more extended culture of this, or similar plants, might work about a revolution in our agricultural economics.

Agriculture, after all, is nothing but a very important branch of industrial chemistry, although most people seem to ignore the fact that the whole prosperity of agriculture is based on the success of that photochemical reaction which, under the influence of the light of the sun, causes the carbon dioxide of the air to be assimilated by the chlorophyl of the plant.

It is not impossible that photochemistry, which hitherto has busied itself almost exclusively within the narrow limits of the art of making photographic images, will, some day, attain a development of usefulness at least as important as all other branches of physical chemistry. In this broader sense, photochemistry seems an inviting subject for the agricultural chemist. The possible rewards in store in this almost virgin field may, in their turn, by that effect of superinduction between industry and science, bring about a rapid development similar to what we have witnessed in the advancement of electricity, as well as chemistry, which both began to progress by bounds and leaps, way ahead of other sciences, as soon as their growing industrial applications put a high premium on further research.

Photochemistry may allow us some day to obtain chemical effects hitherto undreamed of. In general, the action of light in chemical reactions seems incomparably less brutal than all means used heretofore in chemistry. This is the probable secret of the subtle chemical syntheses which happen in plant life. To try to duplicate these delicate reactions of nature by our present methods of high temperatures, electrolysis, strong chemicals and other similar torture-processes, seems like trying to imitate a masterpiece of Gounod by exploding a dynamite cartridge between the strings of a piano.

But there are endless other directions for scientific research, relating to industrial applications, which, until now, do not seem to have received sufficient attention.

For instance, from a chemical standpoint, the richest chemical enterprise of the United States, the petroleum industry, has hitherto chiefly busied itself with a rather primitive treatment of this valuable raw material, and little or no attention has been paid to any methods for transforming at least a part of these hydrocarbons into more ennobled products of commerce than mere fuel or illuminants.

A hint as to the enormous possibilities which may be in store in that direction is suggested by the recent work in Germany and England on synthetic rubber; the only factor which prevents extending the laboratory synthesis of rubber into an immense industrial undertaking is that we have not yet learned how to make cheaply the isoprene or other similar non-saturated hydrocarbons which are the starting point in the process which changes their molecules, by polymerization, into rubber.

Nor has our science begun to find the

best uses for such inexpensive and never exhaustible vegetable products as cellulose or starch. Quite true, several important manufactures, like that of paper nitrocellulose, glucose, alcohol, vinegar and some others, have been built on it; but to the chemist at least, it seems as if a much greater development is possible in the cheaper and more extended production of artificial fiber. Although we have succeeded in making so-called artificial silk, this article is still very expensive; furthermore, we have not yet produced a cheap, good, artificial fiber of the quality of wool.

If we have made ourselves independent of Chile for our nitrogen supply, we are still absolutely at the mercy of the Stassfurt mines in Germany for our requirements of soluble potash-salts, which are just as necessary for agriculture. Shall we succeed in utilizing some of the proposed methods for converting that abundant supply of feldspar, or other insoluble potash-bearing rocks, into soluble potash-salts by combining the expensive heat treatment with the production of another material like cement, which would render the cost of fuel less exorbitant? Or shall the problem be solved in setting free soluble potassium salts as a by-product in a reaction engendering other staple products consumed in large quantities?

We have several astonishingly conflicting theories about the constitution of the center of the globe, but we have not yet developed the means to penetrate the world's crust beyond some deep mines—merely an imperceptible faint scratch on the surface—and in the meantime, we keep on guessing, while to-day astronomers know already more about the surface of the planet Mars than we know about the interior of the globe on which we live.

Nor have we learned to develop or utilize the tremendous pressures under which most minerals have been formed, and still less do we possess the means to try these pressures, in conjunction with intensely high temperatures.

No end of work is in store for the research chemist, as well as for the chemical engineer, who can think by himself, without always following the beaten track. We are only at the beginning of our successes, and yet, when we stop to look back to see what has been accomplished during the last generations, that big jump from the rule-of-thumb to applied science is nothing short of marvelous.

Whoever is acquainted with the condition of human thought to-day must find it strange, after all, that scarcely seventy years ago, Mayer met with derision even amongst the scientists of the time, when he announced to the world that simple but fundamental principle of the conservation of energy.

We can hardly conceive that just about the time the Columbia School of Mines was founded, Liebig was still ridiculing Pasteur's ideas on the intervention of micro-organisms in fermentation, which have proved so fecund in the most epoch-making applications in science, medicine, surgery and sanitation, as well as in many industries.

Fortunately, true science, contrary to other human avocations, recognizes nobody as an "authority," and is willing to change her beliefs as often as better studied facts warrant it; this difference has been the most vital cause of her never ceasing progress.

To the younger generation, surrounded with research laboratories everywhere, it may cause astonishment to learn that scarcely fifty years ago, that great benefactor of humanity, Pasteur, was still repeating his pathetic pleadings with the French government to give him more suita-

ble quarters than a damp, poorly lighted basement, in which he was compelled to carry on his research; and this was, then, the condition of affairs of no less a place than Paris, the same Paris that was spending, just at that time, endless millions for the building of her new Opera-Palace.

Such facts should not be overlooked by those who might think that America has been too slow in fostering chemical research.

If the United States has not participated as early as some European countries in the development of industrial chemistry, this was chiefly because conditions here were so totally different from those of nations like Germany, England and France, that they did not warrant any such premature efforts.

In a country so full of primary resources, agriculture, forests, mines and the more elementary industries directly connected therewith, as well as the problems of transportation, appealed more urgently to American intellectual men of enterprise.

Why should anybody here have tried to introduce new, difficult or risky chemical industries, when on every side, more urgently important fields of enterprise were inviting all men of initiative?

Chemical industries develop along the lines furnished by the most immediate needs of a country. Our sulphuric acid industry, which can boast to-day of a yearly production of about three million tons, had to begin in an exceedingly humble way, and the first small amounts of sulphuric acid manufactured here found a very scant outlet.

It required the growth of such fields of application as petroleum refining, superphosphates, explosives and others, before the sulphuric acid industry could grow to what it is to-day.

At present similar influences are still dominating our chemical industries; they are generally directed to the mass production of partly manufactured articles. This allows us to export, at present, to Germany, chemicals in crude form, but in greater value than the total sum of all the chemical products we are importing from her; although it can not be denied that a considerable part of our imports are products like alizarine, indigo, aniline dyes and similar synthetic products which require higher chemical manufacturing skill.

In this connection, it may be pointed out that our exports of oleomargarine, to Germany alone, are about equivalent to our imports of aniline dyes.

But all this does not alter the fact that in several important chemical industries, the United States has been a pioneer. Such flourishing enterprises as that of the artificial abrasives, carborundum and alundum, calcium carbide, aluminum and many others, testify how soon we have learned to avail ourselves of some of our water-power.

One of the most important chemical industries of the world, the sulphite cellulose industry, of which the total annual production amounts to three and a half million tons, was originated and developed by a chemist in Philadelphia, B. C. Tilgman. But its further development was stopped for awhile on account of the same old trouble, lack of funds, after $40,000 were spent, until some years later, it was taken up again in Europe and reintroduced in the United States, where it has developed to an annual production of over a million tons.

What has been accomplished in America in chemical enterprises, and what is going on now in industrial research, has been brilliantly set forth by Mr. Arthur D. Little.[2]

Nor at any time in the history of the

[2] *Journal of Ind. and Eng. Chem.*, Vol. 5, No. 10, October, 1913.

United States was chemistry neglected in this country; this has recently been brought to light in the most convincing manner by Professor Edgar F. Smith of Philadelphia.[3]

The altruistic fervor of that little group of earlier American chemists, who, in 1792, founded the Chemical Society of Philadelphia (probably the very first chemical society in the world), and in 1811, the Columbia Chemical Society of Philadelphia, is best illustrated by an extract of one of the addresses read at their meeting in 1798:

> The only true basis on which the independence of our country can rest are agriculture and manufactures. To the promotion of these nothing tends in a higher degree than chemistry. It is this science which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various species of manure, and it is by means of a knowledge of this science that he is enabled to pursue the metals through the various forms they put on in the earth, separate them from substances which render them useless, and at length manufacture them into the various forms for use and ornament in which we see them. If such are the effects of chemistry, how much should the wish for its promotion be excited in the breast of every American! It is to a general diffusion of knowledge of this science, next to the virtue of our countrymen, that we are to look for the firm establishment of our independence. And may your endeavors, gentlemen, in this cause, entitle you to the gratitude of your fellow-citizens.

This early scientific spirit has been kept alive throughout the following century by such American chemists as Robert Hare, E. N. Horsford, Wolcott Gibbs, Sterry Hunt, Lawrence Smith, Carey Lea, Josiah P. Cooke, John W. Draper, Willard Gibbs and many others still living.

Present conditions in America can be measured by the fact that the American Chemical Society alone has over seven thousand members, and the Chemists' Club of New York has more than a thousand members, without counting the more specialized chemical organizations, equally active, like the American Institute of Chemical Engineers, the American Electrochemical Society and many others.

During the later years, chemical research is going on with increasing vigor, more especially in relation to chemical problems presented by enterprises which at first sight seem rather remote from the so-called chemical industry.

But the most striking symptom of newer times is that some wealthy men of America are rivaling each other in the endowment of scientific research on a scale never undertaken before, and that the scientific departments of our government are enlarging their scope of usefulness at a rapid rate.

But we are merely at the threshold of that new era where we shall learn better to use exact knowledge and efficiency to bring greater happiness and broader opportunities to all.

However imposing may appear the institutions founded by the Nobels, the Solvays, the Monds, the Carnegies, the Rockefellers and others, each of them is only a puny effort to what is bound to come when governments will do their full share. Fancy that if, for instance, the Rockefeller Institute is spending to good advantage about half a million dollars per annum for medical research, the chewing-gum bill of the United States alone would easily support half a dozen Rockefeller Institutes; and what a mere insignificant little trickle all these research funds amount to, if we have the courage to compare them to that powerful gushing stream of money which yearly drains the war budget of all nations.

In the meantime, the man of science is patient and continues his work steadily, if somewhat slowly, with the means hitherto at his disposal. His patience is inspired by the thought that he is not working for

[3] "Chemistry in America," published by D. Appleton & Co. New York and London, 1914.

to-day, but for to-morrow. He is well aware that he is still surrounded by too many "men of yesterday," who delay the results of his work.

Sometimes, however, he may feel discouraged that the very efficiency he has succeeded in reaching at the cost of so many painstaking efforts, in the economical production of such an article of endlessly possible uses, as Portland Cement, is hopelessly lost many times over and over again, by the inefficiency, waste and graft of middlemen and political contractors, by the time it gets on our public roads, or in our public buildings. Sometimes the chaos of ignorant brutal waste which surrounds him everywhere may try his patience. Then again, he has a vision that he is planting a tree which will blossom for his children and will bear fruit for his grandchildren.

In the meantime, industrial chemistry, like all other applications of science, has gradually called into the world an increasing number of men of newer tendencies, men who bear in mind the future rather than the past, who have acquired the habit of thinking by well-established facts, instead of by words, of aiming at efficiency instead of striking haphazard at ill-defined purposes. Our various engineering schools, our universities, are turning them out in ever increasing numbers, and better and better prepared for their work. Their very training has fitted them out to become the most broad-minded progressive citizens.

However, their sphere of action, until now, seldom goes beyond that of private technical enterprises for private gain. And yet, there is not a chemist, not an engineer, worthy of the name, who would not prefer efficient, honorable public service, freed from party politics, to a mere money-making job.

But most governments of the world have been run for so long almost exclusively by lawyer-politicians, that we have come to consider this as an unavoidable evil, until sometimes a large experiment of government by engineers, like the Panama Canal, opens our eyes to the fact that, after all, successful government is—first and last—a matter of efficiency, according to the principles of applied science.

Was it not one of our very earliest American chemists, Benjamin Thompson, of Massachusetts, later knighted in Europe as Count Rumford, who put in shape the rather entangled administration of Bavaria by introducing scientific methods of government?

Pasteur was right when one day exasperated by the politicians who were running his beloved France to ruin, he exclaimed:

> In our century, science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly, the tiring daily discussions of politics seem to be our guide. Empty appearances! What really leads us forward are a few scientific discoveries and their applications.

PRELIMINARY REPORT ON THE DISCOVERY OF HUMAN REMAINS IN AN ASPHALT DEPOSIT AT RANCHO LA BREA[1]

Introduction

In January, 1914, the Museum of History, Science and Art of Los Angeles, being inconvenienced by heavy rains filling the pits already in process of excavation in the asphalt deposits at Rancho La Brea, began work at a new locality, which was designated as pit number ten. Work was started at a point a short distance southwest of a large pit from which many remains of extinct animals had been obtained in previous years. The point at which excavation was initiated was marked by a seepage from which tar had poured out in comparatively recent time. The excavation of this locality showed the presence of two vents

[1] Read at the Museum of History, Science and Art, Los Angeles, California, June 11, 1914.

or chimneys filled with asphalt. The chimneys were each about three feet in diameter and both had contributed to a hard asphaltic layer forming the surface of the ground at this point. At a depth of about eight feet the chimneys opened into a large dome-shaped asphaltic mass not less than eight feet in diameter and extending downward to an unknown depth.

Remains of many kinds of animals were obtained in both chimneys, but the most interesting discovery was the finding on February 5 of an upper jaw from a human skull, at a depth of a little more than six feet, in the northerly of the two chimneys. Careful investigation of this vent disclosed later almost the entire skull with other portions of the skeleton. The remains evidently belonged to one individual. The bones were found ranging in depth down to a level of about nine feet below the surface, and reaching almost to the point at which the chimney connected with the dome-like reservoir below.

Realizing that this find might prove of exceptional scientific interest, unusual precautions were taken in the excavations following the discovery of the human remains. Under the direction of Mr. Frank S. Daggett, director of the Museum, and of Mr. L. E. Wyman, who had immediate charge of the work in the pits, the excavators obtained all possible information as to the nature of the deposit in which the specimen was found, and every bone appearing in the deposit was saved. The final results of the work give us a complete map of the deposit, and full list of the animal remains from the two chimneys, with their situation in the chimneys.

Through the courtesy of Mr. Frank S. Daggett, director of the Museum of History, Science and Art, it has been the writer's privilege to follow closely the course of the excavations in the pit in which the human remains were found, and to make a study of this most interesting occurrence. Most efficient assistance has been given in every possible way by Mr. Daggett, by Mr. Wyman, and by every one connected with the work. The handling of the excavation by the museum staff, and the careful exercise of precautions necessary to insure the scientific accuracy of the work, are worthy of most favorable comment.

Character of the Problem

As a part of the general problem of the history of the human family, involving questions of the origin and of the true nature of man, the history of the human race in America has interested every thoughtful person. The occurrence of human remains at Rancho La Brea, appearing as it has in close relation to a marvelous representation of life from a past period, has justly demanded attention.

The interest in the human skeleton from Rancho La Brea centers either on peculiarities in the character of the skeleton itself, or in evidences of its antiquity furnished by definite indications of the geologic age of the deposits in which it was found or through proof of age presented by the animals associated with the skeleton.

Nature and Origin of the Deposits Containing Human Remains

Purely geologic evidences of age are often exceedingly difficult to obtain in asphalt deposits, owing to the peculiar mode of accumulation, and the possibility of movement in the deposits after they are once formed. The asphalt is a residue from evaporation of oil. It accumulates either on the surface of the ground or in the midst of other strata into which it has soaked or poured. Even after the asphalt deposit has formed, the nature of the viscous material makes possible considerable movement in many directions within the mass, and consequent change of position of any materials in it.

The deposits in which fossil remains have been found at Rancho La Brea are evidently in part layers formed on the surface, and in part pipes, pockets and chimneys through which oil came up from deeply buried strata. The source of the asphalt or oil is a deep-lying formation, which is considerably folded, and is covered by approximately horizontal layers of clayey and sandy strata washed in from higher land not far away. Oil and gas have

been seeping through the superficial horizontal deposit for a very long period, and have formed more or less definite channels or pipes along lines of least resistance. In some cases these pipes have evidently enlarged themselves locally to chimneys several feet in diameter.

At pit number ten, in which the human remains were discovered, the asphalt deposit consists of two pipes or chimneys connecting with surface flows above. The chimneys arise below from a large dome-shaped asphaltic reservoir. This dome may be an old surface pool now buried and forming a part of the passageway for further upward movement of oil; or it may be an enlargement of a chimney that was originally very much smaller.

The asphalt in the chimneys and in the dome in pit ten was largely a soft, viscous mass containing a high percentage of sand, and including in some regions many angular lumps of hard, weathered asphalt. The contents of the chimneys are entirely unlike the surrounding soil or rock. The material through which the chimneys pass is not homogeneous, but is composed of approximately horizontal strata of clay, sand and gravel, with a small inclusion of asphaltic material in most places. The contact between the chimneys and the matrix through which they pass was everywhere sharply marked.

The sand content of the asphalt in the chimneys and in the reservoir below is quite uniform in grain and in distribution through the mass. The sand may have been mingled with the tar by entrance through the upper end of the chimneys or may have been carried up from below. The available evidence favors the view that it came from the sandy layers from which the oil is seeping upward, or through which the oil passes on the way.

The lumps of hard asphalt embedded in the soft sandy matrix in one chimney are generally of irregular form, and may be much oxidized or weathered. They were evidently derived from asphalt masses that were oxidized by exposure to the weather for a considerable time. They are not found in the dome below and evidently came into the chimney from above.

The chimneys in pit ten may have originated through gradual building up of the walls around open pipes connected with the oil-supply below. They may have developed as channels forced through deposits already formed. Regardless of the mode of origin, the chimneys have certainly been passage-ways through which asphaltic materials have moved sometimes up and sometimes down for a period of unknown extent. It is not improbable that at one time these pipes were longer than at present, the surface of the ground being at a relatively higher level. Erosion may have carried away many feet of deposits at this point, shortening the chimneys much below their length at an earlier time. If the history of these chimneys is like that of some now open in this region, they may have spilled their contents widely at times, and on other occasions, the tar may have receded, so as to leave long empty tubes or chambers. If such a period of recession lasted any great length of time, one would expect the tar around the opening above and adhering to the walls of the tube to be much weathered.

In various ways, dry, oxidized pieces might be broken off around the vent and accumulate as angular fragments below. A later rising of the tar would give a mixture of tar, sand and weathered lumps. If the whole chimney stagnated and oxidized for a time, a later outbreak of oil or asphalt following along the side of the old channel would give two parallel pipes filled with somewhat different materials.

As nearly as one can judge from observations available, the north chimney had a varied history presenting stages like most of those discussed as possibilities. The south chimney, containing only soft, sandy asphalt, evidently had a more uniform history or a shorter history.

Remains of Animals Found in the Pit Containing Human Remains

Bones of birds and mammals were abundant in both chimneys. In the south chimney, which is wide above and narrows sharply below, large bones are found only above the nar-

rowing of the pipe. In the large reservoir below the chimneys only small bones appear, and these were found only in a limited space near the point of union of the lower reservoir and the two chimneys. The distribution of bones shows conclusively that they came from above, and were not carried up from the depths with ascending oil.

The total number of specimens found in the chimneys was large, and will aggregate several thousand. These bones represent a considerable variety of mammals and birds. They include bear, coyote, a wolf of the timber-wolf type, skunk, weasel, horse, antelope, rabbit, pocket-gophers, field-mice, eagles, owls, vultures, crows, and many other forms.

The fauna from the two chimneys in pit ten is in general like that of California at the present time. It differs greatly from that of the pits in which the well-known Rancho La Brea fauna is found through the absence of the great wolf, saber-tooth, sloth, small antelope, camel, and many other mammals and birds abundantly represented in the typical Rancho La Brea deposits.

The only extinct form certainly recognized in the material from the two chimneys is *Teratornis,* a gigantic condor-like bird, as yet known only from Rancho La Brea, and recognized by Dr. L. H. Miller in this collection. Bones of this bird were found in a narrow portion of the north chimney at a depth of about four feet, and considerably above some of the human remains. As nearly as one can judge from the evidence at hand, there seems a reasonable chance that the giant *Teratornis* was a contemporary of the human being whose remains appear in the north chimney of pit ten. The evidence does not present clear proof in favor of this view, but appears to balance in that direction.

The extinct California peacock and two other extinct species are doubtfully reported from the north chimney, but there is doubt as to their having been introduced in the same manner as the other bones making up the fauna.

A small collection found near the upper end of the north chimney contains a number of birds, which, according to Dr. Miller, are quite different from those certainly known from the two chimneys. The matrix in which this small collection was found is also different from that in the chimneys. It seems probable that these specimens really represent an older fauna embedded in a relatively ancient deposit through or near which the north chimney passed.

A portion of the lower jaw of a young horse found at a depth of about five feet and near the *Teratornis* in the north chimney is more slender than any lower jaw of the common extinct horse found in the typical Rancho La Brea fauna. The writer has not, however, compared it with fossil specimens of exactly the same individual stage of development. In slenderness it approaches more closely the jaw of the existing domestic horse. The space between the back teeth and front teeth seems shorter than that in the domestic horse, and is of nearly the same length as in the extinct species from Rancho La Brea. A more careful study of immature specimens from Rancho La Brea in comparison with very young modern horses will be necessary before one can speak authoritatively with reference to the specific determination of this specimen. It will be very interesting to know whether this is an extinct species which lived in California until a comparatively recent time and was contemporaneous with man, but became extinct before this country was visited by white men. The alternative hypothesis is that it represents the colt of a modern horse which fell into the pit within the last century and a half.

The fact that the fauna from the two chimneys is nearly or quite identical with that of the present day, while the typical Rancho La Brea fauna differs greatly and shows close resemblance to the life of the earth at a remote time, makes it evident that the fauna represented in the chimneys of pit ten pertains to a period much later than that in which the typical Rancho La Brea animals lived. The collection from the chimneys represents a time so close to the present that the types of life were nearly the same as those in the region at

the present day. The giant *Teratornis,* and possibly several other extinct forms in this fauna, may indicate that the asphalt in these chimneys was trapping animals at a time removed by some thousands of years from the present. On the other hand, it may be that these species were living here within historic time. A third possibility is that the bones of such extinct species as are found here have been removed in some way from an older deposit, and found a resting place in the chimneys in comparatively recent time. Still more remote is a fourth possibility that in Pleistocene time these chimneys connected with an open pool far above the present surface of the ground; that bones of a few animals trapped at that time sank to the position in which they were found in the excavations; and that after the removal of the upper deposits by erosion, the later or younger fauna was trapped and mingled with the few bones of earlier date.

The Human Remains

The human bones were all found in the north chimney, where the history of accumulation is more complicated than in the south vent. The pit containing the human remains also contains all of the presumably associated specimens representing extinct animals.

The human remains were found rather widely scattered between a depth of about six feet and nine feet. The whole collection of human bones seems to represent one individual. The bones are generally very much worn. The wear in some cases suggests movement within the pit in such a manner that sand in the tar, or resting against the wall of the chimney, has cut away the bone by long-continued rubbing.

Enough of the human skeleton was found in the pit to give a fairly satisfactory idea as to the characteristics of the individual it represents. The skull is that of a small person of middle age, possibly a woman. The brain case is relatively as large as that in some of the living native races of America. According to Dr. A. L. Kroeber the racial characteristics do not differ decidedly from those of people whose remains have been excavated in mounds on Santa Rosa Island off the coast of southern California. So far as the characteristics of the skeleton are concerned, it is not necessary to suppose that we have here an individual who lived at a remote time when the human family was in a relatively low stage of evolution. This skull is not comparable to those of ancient races of the Neanderthal or earlier types. On the other hand, one must not forget that people of a fairly advanced stage of brain development were already in existence at the beginning of the present or Recent geological period.

The characters of the human remains taken by themselves indicate that this person lived either within the present or Recent period, or at a time not earlier than the end of the Pleistocene period immediately preceding it.

Conclusions

A summary of available information regarding the age of the human skeleton found in pit ten at Rancho La Brea is as follows:

1. The evidence of geologic occurrence in the asphalt chimney taken by itself counts for relatively little owing to the peculiar conditions under which these deposits are formed. In so far as this is of value it suggests an age later than that of the tar pits containing the typical Rancho La Brea fauna.

2. The fauna associated with the human remains in pit ten is quite different from the typical Pleistocene Rancho La Brea fauna, and must have inhabited this region at a different period. The fauna in pit ten is closely related to that of the present or Recent period. It is distinctly later in age than the typical Rancho La Brea fauna.

3. The characters of the human remains, taken by themselves, show a stage of development similar to that of man of the present day and not earlier than man of the latest Pleistocene time.

4. The evidence as a whole indicates that the human skeleton from pit ten is of a period much later than that of the typical Rancho La Brea fauna, the time being either within the Recent period or not earlier than the very latest portion of Pleistocene time. The possible association of the human remains with

extinct forms, such as the giant *Teratornis*, may indicate some antiquity for the human being, or may indicate comparatively late persistence of birds or mammals now extinct in this region.

5. Measured in terms of years, it is not possible to give a definite estimate of the age of the skeleton from pit ten. It may suffice to state that this person did not live in the period of the low-browed, Neanderthal, Pleistocene man of Europe. It belongs to the distinctly modern stage of evolution. It does not necessarily belong to the present historic period, but can not be considered as having antedated it by many thousands of years. The age of this specimen may perhaps be measured in thousands of years, but probably not in tens of thousands.

6. The study of the remains at pit ten is a problem similar to that presented by the occurrence of an arrowhead found in a comparatively recent asphalt deposit encountered in the University of California excavations of 1912. The arrowhead was found embedded in a deposit somewhat similar to that in pit ten, and the fauna associated with it was in general of Recent aspect.

7. The final summing up of all evidence relative to the antiquity of the Rancho La Brea skeleton will depend on a very detailed and exhaustive study of the typical Pleistocene Rancho La Brea fauna, of the fauna from the later tar deposits like that of pit ten, and of the existing fauna of California. No one of these three factors is, as yet, satisfactorily known. Until they are all known, the last word on this subject can not be written. The significance of this statement may seem larger when reinforced by the remark that the skeletons of a large percentage of our living species have never yet been carefully studied in the way in which this work must be done for use in investigations such as those concerned in this problem.

From whatever point of view this specimen is considered, it is well worth exhaustive scientific investigation.

JOHN C. MERRIAM

UNIVERSITY OF CALIFORNIA,

June 11, 1914

THE 72-INCH REFLECTING TELESCOPE FOR CANADA

SOME eight months ago the Canadian government entered into contracts for the construction of a 72-inch reflecting telescope, with the J. A. Brashear Company for the optical parts and the Warner and Swasey Company for the mounting. This telescope, which will be considerably larger than any in use, will be of the most modern type and will be used principally in the determination of stellar radial velocities. The progressive policy of the Canadian government in the encouragement of scientific research, as evidenced by the order for this magnificent instrument has now been rendered doubly effective by authorizing at a very considerable additional expense, the total outlay being upward of $200,000, its installation in the best astronomical location in the dominion.

Investigations have been in progress for upwards of a year at five places, representative of different climatic conditions in the country. The region around Victoria, B. C., so much excelled all the others, including Ottawa, in the two most important particulars, the "seeing" or steadiness and quality of definition, and the small daily temperature variation, while being at least equal in other qualifications, that it was strongly recommended to the government by the chief astronomer as the site for the telescope. The government of the province of British Columbia, on being approached for help towards the additional cost of location away from Ottawa, generously contributed $10,000 for the purchase of the necessary land and agreed to build a road, which will cost about $20,000, to the chosen site which is at the summit of Saanich Hill, altitude 732 feet, about eight miles north of Victoria.

Immediately on the decision of the dominion government in favor of this site, fifty acres of land were purchased around the summit of the hill, and arrangements were concluded for the construction of the road this fall. This road will be upwards of a mile and a half in length, leading from the main road and the electric railway at the foot of the hill by a 7 per cent. grade to the summit.

Building operations will begin early in 1915 and the dome should be ready for the telescope in the fall of that year. Word has been received that the 72-inch disc for the mirror has been successfully cast and annealed at St. Gobain, and work on its grinding and polishing will shortly be commenced. The design of the mounting, which has many new features, and will undoubtedly be better and more convenient in operation than any hitherto made, is practically completed and construction work on the heavy steel castings required has been begun. It is hoped, therefore, that the telescope will be mounted and ready for operation by the end of next year.

SCIENTIFIC NOTES AND NEWS

A REPLICA of the bust of Louis Pasteur by Dubois has been presented to the American Museum of Natural History for installation in the hall of public health, through the generosity of Dr. Roux, director of the Pasteur Institute in Paris and M. Vallery-Radot, son-in-law of M. Pasteur.

DR. CHARLES W. ELIOT, president emeritus of Harvard University, has been elected a corresponding fellow of the British Academy.

THE Canadian government has appointed Mr. James White to be assistant chairman of the Commission of Conservation, and Dr. C. Gordon Hewitt, dominion entomologist, to be Canadian representative on the permanent committee of the "International Conference for the Global Protection of Nature."

MR. JAMES BARNES, of the Barnes-Kearton expedition, which crossed Central Africa under the auspices of the American Museum, has returned to New York, bringing with him a series of motion-picture films. Mr. Barnes will give an exhibition of these films to the members of the museum in the fall.

THE Royal Institute of Public Health, in pursuance of the terms of a trust which enables it to award annually a gold medal to a public health medical official, at home or abroad, in recognition of conspicuous services rendered to the cause of preventive medicine within the British empire, has conferred the medal for 1914 upon Mr. James Niven, medical officer of health for Manchester.

WE learn from *Nature* that the honorary freedom of Newcastle-on-Tyne was conferred on Hon. Sir C. A. Parsons on July 10 in recognition of his achievements in science, particularly as the inventor of the steam turbine. It had been decided to confer a similar honor on Sir Joseph W. Swan, but he has since died. The symbols of the freedom—a scroll and casket—have, however, been presented to a representative of his family.

SIR JOHN TWEEDY, formerly president of the Royal College of Surgeons of England, has been elected president of the Medical Defence Union, in the room of Dr. Edgar Barnes.

V. I. SAFRO (Cornell, '09), formerly of the U. S. Bureau of Entomology and the Oregon Agricultural College, has been appointed entomologist with the Kentucky Tobacco Product Company, of Louisville, Kentucky.

THE following list of members of the Imperial Transantarctic Expedition is given in *Nature: Weddell Sea Party*—Sir Ernest H. Shackleton, leader of the expedition; Mr. Frank Wild, second in command; Mr. G. Marston, Mr. T. Crean, Captain Orde Lees, Lieutenant F. Dobbs, Lieutenant Courtney Brocklehurst, Mr. J. Wordie, geologist; Mr. R. W. James, physicist and magnetician; Mr. L. H. Hussey, assistant magnetician and meteorologist; Mr. F. Hurley, photographer and kinematographer; Mr. V. Studd, geologist; Lieutenant F. A. Worsley, in navigating command of the *Endurance* on the voyage from London to Buenos Aires and the Weddell Sea, and afterwards to take part in the surveying and exploring of the coast; Mr. Jeffreys, Mr. Hudson and Mr. A. Cheetham. *Ross Sea Party*—Lieutenant Aeneas Mackintosh, leader and meteorologist; Mr. E. Joyce, zoologist; Mr. H. Ninnis; Mr. H. Wild, and Dr. Macklin, surgeon. There only remain two vacancies, and these are to be filled by another doctor and a biologist. The arrangements for the Ross Sea ship *Aurora* are not yet quite

complete, but the *Endurance*, with the Weddell Sea party, has now sailed.

A BILL to extend the thanks of congress to the engineering members of the Isthmian Canal Commission has been reported to the House with a favorable recommendation by the Military Affairs Committee. The men who would receive this honor are Colonel George W. Goethals, General William C. Gorgas, Colonel H. F. Hodges, Lieutenant Colonel William L. Sibert and Civil Engineer H. H. Rousseau. The bill authorizes the president to advance Colonel Goethals and General Gorgas to the rank of Major General, the former of the line and the latter of the medical department. It is provided also that the president may, upon the retirement of Colonel Hodges, Lieutenant Colonel Sibert and Civil Engineer Rousseau, advance each of these officers one grade on the retired list.

SIR CLEMENTS MARKHAM has unveiled at Cheltenham a statue of Dr. Edward Adrian Wilson, who was born in that town, and perished with Captain Scott on the great ice barrier in March, 1912. The statue was designed by Lady Scott.

PROFESSOR FRANCIS HUMPHREYS STORRER, from 1865 to 1870 professor of chemistry in the Massachusetts Institute of Technology and, from 1870 to his retirement as emeritus professor in 1907, professor of agricultural chemistry at Harvard University, has died at the age of eighty-two years.

THE Rev. Horace Carter Hovey, fellow of the Geological Society of America and of the American Association for the Advancement of Science, known especially for his publications on caverns and subterreanean fauna and flora, died at his home at Newburyport, Mass., on August 27, in his eighty-second year.

DR. FREDERIC LAWRENCE KORTRIGHT, B.S. (Cornell, '90), Sc.D. (Cornell, '95), instructor in chemistry at Cornell University from 1892 to 1899, and subsequently assistant professor and professor at the University of West Virginia, author of contributions on the rare earths, citric acid, silica and other chemical subjects, died on July 13, at the age of forty-seven years.

PROFESSOR FRANKLIN WILLIAM HOOPER, director of the Brooklyn Institute of Arts and Sciences, the author of contributions on algæ and glacial geology, died on August 1 at the age of sixty-three years.

THE Rev. Osmond Fisher, at one time tutor of Jesus College, Cambridge, known for his important contributions to geology, died on July 12, at the age of ninety-six years.

THE death is announced, in his sixty-sixth year, of Sir Christopher Nixon, ex-president of the Royal College of Physicians of Ireland, and Vice-Chancellor of the National University of Ireland.

PROFESSOR PAUL RECLUS, the distinguished Paris surgeon, died on July 29, in his sixty-eighth year.

THE U. S. Civil Service Commission announces an examination for plant physiologist, experienced in plant metabolism, for men only, to fill a vacancy in the Bureau of Plant Industry, Department of Agriculture, at a salary of $3,000 a year. A Ph.D. or D.Sc. degree from a college or university of recognized standing, and at least five years' experience in plant physiology since receiving the bachelor's degree, are prerequisites for consideration for this position. Applicants must have reached their twenty-fifth but not their forty-fifth birthday on the date of examination.

THE Royal Agricultural Society of England is offering a medal for a monograph or essay, which has not been previously published, giving evidence of original research in any agricultural subject or any of the cognate agricultural sciences applicable to British farming.

THE German Paleontological Society is to hold its annual meeting this year in London at the British Museum of Natural History on September 2 to 5. On September 5 and 6 the members will visit Oxford, and on September

7, Cambridge. The society now has 210 members, of whom 19 are Americans.

The eighty-second annual meeting of the British Medical Association was held at Aberdeen on July 28, 29, 30 and 31, under the presidency of Sir Alexander Ogston. The address in medicine was given by Dr. A. E. Garrod, and that in surgery by Sir John Bland-Sutton. Professor J. Arthur Thomson delivered the popular lecture. Sixteen scientific sections were arranged as follows: Anatomy and physiology; dermatology and syphilology; diseases of children, including orthopædics; electro-therapeutics and radiology; gynæcology and obstetrics; laryngology, rhinology and otology; medical sociology; medicine; naval and military medicine and surgery; neurology and psychological medicine; ophthalmology; pathology and bacteriology; pharmacology; therapeutics and dietetics; state medicine and medical jurisprudence; surgery; tropical medicine.

The selection committee for the Captain Scott Memorial in London has unanimously chosen the design submitted by Mr. Albert H. Hodge. The London *Times* gives the following description of the plan of the Antarctic Monument: "A granite pylon is surmounted by a bronze group representing Courage sustained by Patriotism, spurning Fear, Despair and Death, the figure Courage being crowned by Immortality. Below the group the words 'For King,' 'For Country,' 'For Brotherly Love,' and 'For Knowledge' are inscribed. The front of the pylon bears the names of the five heroes, whose portrait medallions in bronze occupy the most prominent position on the monument. The medallions are brought into relationship by a broad band of laurel leaves. On the back of the monument is placed a trophy composed of a pair of snow shoes, a replica of the cross erected on Observation Hill, and a wreath—relics of the journey. Beneath are Scott's words: 'Had we lived, I should have had a tale to tell of the hardihood, endurance and courage of my companions, which would have stirred the heart of every Englishman.' Forming a base to the pylon is a podium, on the four sides of which are placed bronze relief panels depicting the Expedition. The subjects for these panels are taken from the inscription at Observation Hill: 'To strive' (showing the difficulties surmounted on the journey); 'To seek' (showing the start for the pole); 'To find' (showing the party at the pole); 'And not to yield' (showing the tent covered with snow—the last resting-place of the heroes). The whole monument is placed within a square raised upon steps, the total height being about 37 feet."

The Geological Survey has been issuing its final statistics of the 1913 mineral production which confirms in detail the preliminary estimates issued early in January for the principal minerals. In the large majority of cases these figures tell in one way or another the same story of industrial prosperity. In coal production the increase has been general, and it is this very fact that serves as an unmistakable index of general health in the industrial world. But as state after state is shown to have had its banner coal year—West Virginia, Illinois, Ohio, Kentucky, Alabama, Virginia, Oklahoma, New Mexico, Montana, Texas, Utah and Pennsylvania in both bituminous and anthracite, the record becomes spectacular. Ohio for instance had its floods, yet there was a substantial 6 per cent. increase in coal output, and the miners averaged more working days in 1913 than in 1912. Twelve other states showed increases varying from 3 per cent. in Iowa to 12 per cent. in Indiana and over 15 per cent. in Washington, and only Colorado, Maryland, North Dakota, Nevada, Idaho and Missouri show decreased output, the Colorado labor troubles explaining the only significant decrease. In a similar way, the figures of coke production give large increases, and coke, it may be noted, is a step nearer the metal industry. Petroleum production in 1913 exceeded all records, an increase of 25 million barrels and 72 million dollars over the 1912 returns. In metal mining, the iron and zinc mines had a banner year, while gold, silver, lead and copper showed a decline in many of the largest producing states. Structural materials on the other hand exhibit

marked gains almost without exception. Thus 1913 was the banner year for cement, which gains more than 11 per cent. over 1912, and record outputs are also shown for lime, building sand and gravel, sand-lime brick and glass sand. Other mineral products for which 1913 was a record-breaking year, are bauxite and aluminum, sulphuric acid, feldspar, mica, pottery, and talc and soapstone, while substantial increases are reported for gypsum, phosphate rock, abrasives, barytes, slate and salt. These production figures all express well-maintained activity in mines, smelter, furnace and mill, and prove that the American people are utilizing more of the nation's great natural resources than ever before. A few weeks later when figures are at hand for all of the mineral products, it is expected that 1913 will be found to have overtopped both 1912 and 1907 which have hitherto held the record.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ASA G. CHANDLER has given $1,000,000 and citizens of Atlanta have guaranteed $500,000 for the establishment of an Atlanta University, under the auspices of the Methodist Church. It is said that a theological school will be the first to be opened.

BOWDOIN COLLEGE has received a gift of $15,000 from the estate of Dr. Frank Hartley, of New York, to establish a scholarship fund as a memorial to the testator's father, John Fairfield Hartley, of the class of 1829.

THE following changes take effect in the botanical department of the Michigan Agricultural College, September 1: Mr. E. F. Woodcock, of the botanical department of West Virginia University, has been appointed instructor in botany to succeed Dr. R. F. Allen, who has recently accepted a similar position at Wellesley. Professor H. T. Darlington, of Washington State College, has been appointed assistant professor of botany and will have especial charge of the botanical garden and herbarium. An industrial fellowship in cucumber diseases has been established by the H. J. Heinz Pickle Company, and is filled by Mr. S. P. Doolittle, who graduated from the institution this year.

IN the law department of Tulane University of Louisiana, Mr. C. P. Fenner, professor of Louisiana practise and acting professor of civil law, has been appointed dean of the department to succeed Mr. D. O. McGovney, who has been called to the University of Missouri.

DR. NATHAN FASTEN, Ph.D. (Wisconsin), has been appointed instructor in zoology at the University of Washington, Seattle.

MR. FREDERICK SODDY, lecturer in physical chemistry in the University of Glasgow, has been appointed to the chair of chemistry at the University of Aberdeen, in succession to Professor F. R. Japp.

PROFESSOR J. S. MACDONALD, professor of physiology in the University of Sheffield since 1903, has been appointed Holt professor of physiology in the University of Liverpool, in succession to Professor C. S. Sherrington.

MR. G. N. WATSON, M.A., fellow of Trinity College, Cambridge, has been appointed a member of the staff of the department of pure mathematics at University College, London, for the next year to fill the vacancy created by the resignation of Dr. A. N. Whitehead.

MR. T. B. JOHNSTON, M.B., lecturer on anatomy in the University of Edinburgh, has been appointed to the newly-created office of lecturer and demonstrator in anatomy at University College, London.

DISCUSSION AND CORRESPONDENCE

THE PROBLEM OF GRAVITY

TO THE EDITOR OF SCIENCE: Some recent public utterances from sources that command attention and respect in the scientific world as well as among the general public illustrate rather forcibly the crude and confused state of thought on this subject that continues to prevail up to the present day. These also suggest that the ordinary and obscure thinker need not be deterred from attempting a contribution that may possibly be helpful by the feeling of greatly superior attainments in this

direction by the recognized giants of science. It is axiomatic that a clear conception of what a problem really *is* is a prerequisite to its successful solution. I ask to be permitted to offer the following enunciation:

Neither a quest for an "explanation" of the cause or nature of gravity, on the one hand, nor a mere non-logical acceptance of the fact as a matter of belief or blind faith, on the other, but *the evolutionary development in the minds of men of a scientific satisfaction not only with not knowing but with not ever being able to find out* any rational and consistent theory or explanation for the attraction influence among all portions of matter which is called *gravity* and which is the essential, universal and unalterable attribute of all material things whatsoever.

Obviously such a conception involves rather more of philosophy and psychology than of so-called physical science.

John Millis

A SIMPLE METHOD FOR FILLING AN OSMOMETER

In setting up the type of apparatus ordinarily used in elementary classes to demonstrate osmosis, the thistle-tube is filled with molasses or strong sugar solution. If this is done before the membrane is tied on, the apparatus becomes sticky and the difficulty increased. If, on the other hand, the tube is filled after the membrane is secure, it is very difficult to force the liquid down the narrow stem.

For the last two years I have found the following to be a simple and effective method for filling the tube. Take a perfectly dry thistle-tube, fill it with dry granulated sugar to the flare at the top, and then tie on the wet membrane with a waxed thread. When the tube is inverted the sugar will fill the bulb. With the solution of the lowest layer of sugar in the water of the membrane, the osmotic action is started and the liquid rises in the tube. First observations may be taken when a saturated solution has been formed and no dry sugar remains.

Laetitia M. Snow

Wellesley College

QUOTATIONS

THE PROPOSED UNION OF SCIENTIFIC WORKERS

We continue to receive replies to our notice regarding the emoluments of scientific workers; and they emphasize the opinions which have already been expressed in the leading article of the April number of this *Quarterly*. For example, one worker, a London graduate with first-class honors, who has published original research work and is now a demonstrator working two or three days a week, and who also gives two courses of post-graduate lectures with demonstrations, and does other work, receives the generous salary of fifty pounds per annum—much less than most unskilled laborers will work for. We hear that in one British university, out of two hundred members of the junior staff in all departments (that is all members of the teaching staff who are not full professors), not more than six receive a stipend greater than two hundred and fifty pounds a year. There appears also to be some fear amongst junior staff workers that if they divulge particulars of their salaries they will lose their posts; and in one case we are informed that some highly specialized workers seem even to have lost the ambition ever to earn a reasonable wage. In addition to the poorness of the pay, complaints are made regarding the entire absence of any provision for adequate pension and also regarding the state of serfdom in which men of science are kept under boards and committees composed of persons who frequently have no qualifications for the exercise of such authority. The whole picture is a melancholy not to say a disgraceful one for so wealthy a country, which also imagines that it possesses the hegemony of the world. On the other hand, much sympathy is expressed on behalf of any endeavors that may be made to remedy these evils, and men of science appear to be awakening to the fact that they should attempt some combined effort in this direction. We note especially an excellent article on the "Income and Prospects of the Mathematical Specialist," by Professor G. H. Bryan, F.R.S., in the April number of the *Cornhill Magazine,* and an admirable lecture on the "Place of Science in Modern

Thought," by George Idle, Esq., M.I.N.A., delivered at the Royal College of Science, Dublin, on January 27, which suggests at least the position which scientific work should hold in a modern state. Moreover, the lay press is beginning to consider the subject, entirely with sympathy for the scientific worker; and we should like to give special commendation to the efforts being made by the *Morning Post* in its series of articles and letters published during May and June.

The question now arises as to what had best be done under the circumstances; and it has been suggested that those who wish to do so would be wise to form a union of some kind with a program specifically aimed at improving the position of the workers themselves. At present there are numerous societies which are supposed, more or less indirectly, to attend to this very necessary work, but which certainly have not achieved much success in it. We should therefore like to receive any suggestions upon the subject, together with the names of those who may feel inclined to join such a movement if the program ultimately decided upon meets with their approval.—*Science Progress.*

SCIENTIFIC BOOKS

The Osteology of the Chalicotheroidea, with special reference to a mounted skeleton of Moropus elatus Marsh, now installed in the Carnegie Museum. By W. J. Holland and O. A. Peterson. Memoirs of the Carnegie Museum, Vol. III., No. 2. Pittsburgh, December, 1913, pp. i–xvi, 189–411, with 115 text figures, and plates XLVIII.–LXXVII.

The Chalicotheroidea, a curious aberrant group of Perissodactyl ungulates wherein the hoof bones have departed widely from the normal type, becoming laterally compressed, deeply fissured and claw-like, form the subject of this volume. The Carnegie Museum was fortunate in securing through the efforts of Messrs. O. A. Peterson and W. H. Utterbach an almost complete skeleton of the remarkable *Moropus elatus* Marsh, by means of which the entire osteology of a typical member of the group has been worked out.

The locality of this specimen lay not far from that whence one of Professor Marsh's collectors, H. C. Clifford, secured the somewhat fragmental material which constitutes the type of the species *elatus*. Clifford's discovery in the spring of 1875 was destined to be followed years later, in 1904, by the finding on the upper Niobrara River in western Nebraska of one of the most remarkable bone deposits in the world, the Agate Spring quarry of Lower Miocene age; and it is this locality, which has been worked successively by the representatives of several institutions, Carnegie Museum, American Museum, University of Nebraska, Amherst and Yale, which has produced a number of skulls and skeletons of this type, among them the one forming the basis of this memoir. While Dr. Holland is the senior author of the memoir, Mr. Peterson is credited with the recovery of much of the material, its preparation for study and description and the partial preparation of those sections of the paper which relate to the appendicular skeleton, and to the skull and dentition.

The introductory chapter gives a history of the excavations at the Agate Spring quarries and tells of the conditions of deposition as follows (pp. 194–95):

"The 'Agate Spring quarries' . . . are situated in the Lower Harrison Beds (Miocene) and contain a vast quantity of the remains of extinct mammalia many of which, before the specimens were firmly embedded in the matrix, had suffered more or less displacement. It is rarely that the bones are found collocated in their true order, though in some instances a dozen or more vertebræ may occur in regular series, with the corresponding ribs attached to them, or the bones of an entire limb may be found in place. The region, at the time when the bones were deposited, was probably a great plain, traversed by a broad and shallow river, like the Platte, or the Missouri, subject at times to overflows. It was a region of flat alluvial lands, which may in the summers have been in part dried, leaving here and there pools of water to which the animals

of the region resorted, as in South Africa at the present time herds of ungulates resort to such places. . . . At these pools the beasts, which roamed over the wide plain, came to drink, and here they died, as the result of age, or as they fell under the teeth and claws of carnivora. It may also have been . . . that at this particular point there was a ford, or crossing of the river, much resorted to by migrating herds of animals, and here many, especially younger animals, were mired in quicksands, and drowned."

Chapter I. defines the Chalicotheroidea, sketches briefly the literary history of the group, and names and defines the three subfamilies, Schizotheriinæ, Moropodinæ and Macrotheriinæ; while Chapter II. characterizes the various genera included under each subfamily, both the American and Old World forms, as well as several genera formerly included under the Chalicotheroidea but now referred to other orders and suborders.

In Chapter III. a résumé of the species is given, although, with the Old World types especially, a thorough revision other than of the genotypes was not practicable; at the same time the comprehensive list is of great value for future work. Chapter IV. treats very fully each species of the genus *Moropus*, discussing each one under the several headings of name and synonyms, of what the type consists and its whereabouts, the geological horizon, and the specific characters. The last named includes not only the original description quoted in full, but an adequate supplemental description as well.

Chapter V., embracing as it does 143 pages, is really the *pièce de résistance* of the entire volume, and presents an elaborate morphological study of *Moropus*, based very largely upon the skeleton of *M. elatus* already referred to, which has been mounted in the Carnegie Museum. The assembled skeleton shows certain horse-, rhinoceros- and titanothere-like features, while the feet are so like those of the Edentata as to have been the cause of the inclusion of *Moropus* in that order before the association with other anatomical features was known. The restoration of *Moropus* based upon the articulated skeleton is given in the form of a statuette prepared by Theodore A. Mills under the supervision of the authors, and presents a curious admixture of horse-like head, tapir-like body, and leonine feet. Of its probable habits and the meaning of the peculiar adaptive features the authors are perhaps wisely silent, though a host of questions present themselves upon viewing this grotesque re-creation.

Chapter VI. gives an elaborately studied bibliography, in which the essential facts of each paper are analyzed, showing a very intimate knowledge of the literature of the subject on the part of the authors.

This work, on the whole, is entitled to the highest commendation as an elaborate, painstaking piece of research which will prove of the greatest value to future students of the group, and the fine appearance of the volume is fully commensurate with its importance.

Richard Swann Lull
Yale University

Atlas und Lehrbuch wichtiger tierischer Parasiten und ihrer Ueberträger mit besonderer Berücksichtigung der Tropenpathologie. By Prof. Dr. R. O. Neumann (Bonn) and Dr. Martin Mayer (Hamburg). Lehmann's Medizinische Atlanten. J. F. Lehmann's Verlag in München. Bd. XI., vi + 580 + 93 pp., 45 colored plates with 1,300 figures and 237 figs. in text, 1914. Geb. M. 40.

The high standard of excellence established in the previous volumes of Lehmann's series of atlases, which includes, among other well-known texts, Sobotta's superb work on anatomy and histology, is well maintained in Neumann and Mayer's recently published "Atlas und Lehrbuch wichtiger tierischer Parasiten." The rapid growth of interest in tropical diseases, the recent expansion of the sciences of protozoology and parasitology, the increasing number of institutions devoted to research in these fields, and the rapid rise of applied hygiene and preventive medicine, have created both the possibility and the need for such a work as this. One has but to glance through the group

of lesser texts which have been issued of late to meet the growing demand for a usable summary for purposes of instruction, to see how large a use has been made in them of old figures which have done duty for decades in older texts, and to be impressed with the wealth of unutilized materials when reference is made to original sources. The time and care needed in the preparation of new illustrations and publishers' reluctance to risk the expense of new cliches and of colored plates is doubtless responsible in part for this situation.

The atlas in hand is far removed from any such criticism, for the thirteen hundred figures on the forty-five colored lithographed plates are from original colored drawings by Professor Neumann, and the publisher has spared neither pains nor expense to insure adequate reproduction, more than twenty colors being employed in some of the plates to bring out satisfactory results. The extensive collections of the Institut für Schiffs- und Tropenkrankheiten at Hamburg have furnished much of the original material upon which the work is founded. Authors have also contributed their original preparations for the preparation of the illustrations. For example, Looss, of Cairo, has contributed hookworm and *Schistosomum* material, Manson filaria, Prowazek trachoma, and Chagas his Brazilian *Schizotrypanum,* the causative agent of the South American "sleeping sickness." Japan, Ceylon, Cairo, Congo, Nigeria, Brazil, the Schools of Tropical Medicine in Hamburg, Liverpool and their outposts in the tropics have contributed richly to the resources utilized in this work.

It has been the aim of the authors to include all forms of clinical importance and such other related forms as are of theoretical interest. The work was instituted in 1905, but the growth of the subject has been so rapid that its publication has been delayed, with the result that the work has been greatly enriched by recent discoveries. Obviously no book of even the sumptuous form of this atlas could be expected to be encyclopedic. A vast deal of elimination of detail, of selection of material which has passed to the stage of reasonable certainty, and the omission of that of more problematical status has been essential. The authors have been very skilful in this respect, though one questions their inclusion of Prowazek's figure of "conjugation" in *Trypanosoma,* for it would seem that the evidence for sexual reproduction in the trypanosomes is as yet inconclusive.

The book unites the fields of zoology and medicine and has been written with both in view, though naturally many details of systematic, cytological and anatomical nature are eliminated, or presented only in condensed form. On the other hand, life-histories of the parasite and its carrier-host, and the pathological conditions which it induces, are subject to both discussion and illustration.

The structure of the elements of normal blood is very fully illustrated and the technique of hematology is elaborated and methods of staining, preservation, culture, collecting and sending parasitological material are detailed, usually with figures illustrative of apparatus and method. References to literature are well chosen and ample. Considerably more than half of the work is given to the Protozoa and to their invertebrate hosts, the flies, mosquitoes, bugs and ticks, five plates being devoted to trypanosomes and no less than five to the malarial parasite. It is perhaps because of this wealth of protozoological illustration that one gets the impression that the parasites belonging to the higher phyla, the worms and arthopods, have received, relatively to their importance, less ample treatment. But to have done more would have inevitably necessitated a second volume. It also seems that the parasitic flagellates, other than trypanosomes, and ciliates call for fuller treatment than has been accorded them.

While the emphasis is placed upon human parasites, the treatment is not restricted to them; the additions, however, are more by way of biological inclusiveness than for the purposes of comparative medicine. The work can hardly serve the purposes of the veterinarian, though indispensable in all fields of parasitology.

The authoritative character of the work, the

accuracy, completeness and utility of the illustrations to the clinician and practitioner, the broad biological conception underlying the treatment, combine to characterize the work as the best iconography of parasitology as yet published.

Charles A. Kofoid
University of California

THE RELATION BETWEEN LIZARDS AND PHLEBOTOMUS VERRUCARUM AS INDICATING THE RESERVOIR OF VERRUGA

It affords the writer much satisfaction to record another confirmation of the intimate relation which exists between *Phlebotomus* and lizards or other reptiles the world over. Many cases of this relation have been recorded in the recent literature, and the same appears to hold good in Peru.

Numerous blood smears made during the past two or three months from small rock lizards of several species collected at Verrugas Canyon, Surco, San Bartholomé and Chosica Canyon all show rod and granule bodies which exhibit the identical morphology of the bodies that have been named *Bartonia bacilliformis.* Their agreement with the latter in shapes, sizes, colors and apparent structure is so faithful as to defy distinction. The lizards concerned have been sent in for identification.

It is to be noted that the first three localities above mentioned are well within the limits of the verruga zone of the Rimac Valley, while Chosica Canyon is just outside that zone. Lizard blood smears made in Chosica Canyon in June, 1913, and again recently all show these bodies, but the granules seem to predominate greatly in the blood of the lizards from outside the verruga zone and from points within the zone where the lizards are not exposed to the constant attacks of the *Phlebotomus.*

In Verrugas Canyon there are, close to the house, many large walls built of loose rock wherein the *Phlebotomus* hide in swarms during the day, issuing in the evening to enter the house and bite the inmates. These rock walls are also inhabited by the small lizards in question. Smears of blood made from lizards from these walls show a great predominance of the rods over the granules. These lizards are exposed to the constant attacks of the *Phlebotomus* every day in the year.

The writer has found the same bodies in smears made from the *Phlebotomus* at Verrugas Canyon, which also show the nucleated red corpuscles of the lizards as well as mammalian erythrocytes. The same rods and granules have furthermore been found by the writer in microtome sections of human verruga papules, in similar sections of papules produced in his laboratory animals by injections of the *Phlebotomus,* and in the blood of these animals prior to the eruption.

Blood smears of a young guinea-pig taken 63½ hours, and later, after injection subcutaneously with a very small quantity of citrated lizard blood from Chosica Canyon have shown the typical granules and Bartonia rods in the disks of the erythrocytes. This pig died nine days after injection, after irregular rises of temperature, and its autopsy blood and femoral marrow showed a large increase of the bodies, principally granules but also short rods.

Subcutaneous injection of a second young guinea-pig with a larger quantity of citrated lizard blood from Surco proved fatal within ten hours, liver smears showing the rods and granules, but blood, marrow and spleen smears proving practically negative. Further experiments of a similar nature are under way. The three-cornered connection, however, between lizards, *Phlebotomus* and verruga appears to be already well established by these data.

It is seen from the results that this possible reservoir of verruga in the lizards is not confined to the verruga zones, which are limited by the occurrence of the *Phlebotomus,* but may exceed the latter in range. This explains how fluctuations in occurrence of the *Phlebotomus* may result in extensions or retractions of the verruga zones, the gnats finding the infection at hand on gaining a new locality.

It also seems indicated by the above results that the verruga organism must exist in the infective stage in the lizard blood and does not apparently demand the medium of the *Phlebo-*

tomus for its development but only for its transfer to new hosts. Thus the *Phlebotomus* appears to be merely a mechanical transmitter of verruga, and not a true secondary host of the organism. But it is probable that the gut of the *Phlebotomus* favors the free liberation of the infective stage of the organism, which either penetrates thence to the salivary glands or passes directly forward through the alimentary canal, by regurgitation or otherwise, to the pharynx and thus gains the proboscis.

It seems demonstrated by the above findings that these small rock lizards constitute at least one reservoir of verruga. Whether snakes, man or other mammals constitute additional reservoirs of the disease remains to be determined. The writer puts forth the tentative opinion, subject of course to future modification, that lizards and possibly snakes, in other words reptilian animals of cold blood, may yet be found to constitute the sole reservoir of verruga. It seems quite possible that *Phlebotomus* can not become infected with verruga from the blood of mammals, but this point needs careful investigation.

As bearing on this view, it is to be noted that no one has yet succeeded in making cultures of the Bartonia bodies from human blood, and that injections of mammalian blood containing these bodies have given only negative results thus far. The verruga organism might be looked upon as outside its natural environment in mammalian blood, but at home in reptilian hosts. Nevertheless it is quite possible that it has been overlooked in the experiments after making the injections of Bartonia containing blood referred to.

The above rods and granules have also been found by the writer in the bone marrow, liver and spinal cord of the lizards, as shown by smears from these organs. In the blood of the lizards the rods and granules are often free in the plasma but frequently in or attached to the surface of the red corpuscles. They stain with Giemsa characteristically brownish, sometimes bluish or reddish, exactly as do the Bartonia. If these organisms are not identical with the Bartonia, they are certainly very similar morphologically and evidently bear a constant relation to verruga. It has not been possible as yet to attempt cultures of these bodies with the view of demonstrating their nature, owing to lack of both time and facilities. They may easily turn out to be the bacillus paratyphoid B, in large part at least, but in any case they seem linked with Bartonia in some thus-far mysterious relation.

There is quite a large possibility that the Bartonia may prove to be simply the lizard-blood bodies parasitized by the verruga organism proper. From 1900 to 1902 Barton demonstrated the bacillus paratyphoid B in all his verruga cases, and with it he produced the fever and eruption in both dogs and mules. Since this bacillus is so constantly present in verruga cases it seems certain to the writer that it bears some important relation to the disease. As it has been cultivated with ease, while Bartonia has not, it may well be the case that the latter is simply an infected form of it which has lost its reproductive power. In such event the verruga organism does not reach the infective stage until the Bartonia containing it has broken up naturally and disappeared. Barton's animal experiments seem strongly to indicate that the bacillus paratyphoid B carries verruga infection.

Similar cases of the constant attendance of certain bacilli upon diseases of obscure etiology, as yellow-fever, hog-cholera, etc., are well known. It may well be that such bacilli are infected with the respective ultramicroscopic organisms of these diseases and play an important rôle in their carriage.

Whether the intracorpuscular bodies found by Laveran and Carini in the blood of lizards are of the same type as the present rods and granules remains to be seen. It would seem quite likely that the two may be closely related. The present bodies, which are only tentatively assumed to be Bartonia or to metamorphose abnormally into the latter, exhibit much resemblance to Theileria. The granule stage also approaches the marginal-point stage of Anaplasma, and is very similar to the stages figured by Anderson for the Rocky Mountain spotted-fever organism, which is probably not a Piroplasma.

Blood smears of a native rat, probably a species of *Euneomys,* caught at Verrugas Canyon, have shown nothing definite. Smears of the blood of dogs and burros, doves and ground-owls from the same locality have likewise proved negative. The vizcachas, *Viscaccia* spp., are contraindicated as a reservoir of verruga. It has not yet been practicable to secure vizcacha blood smears from the verruga zone, but these animals do not occur close to the house in Verrugas Canyon, where the *Plebotomus* is very abundant in the rock walls, which it evidently leaves only to enter the house or attack persons and animals close by. Therefore these particular gnats are precluded from deriving their infection from the vizcacha, and they are well known to be infected at most times if not continuously.

In conclusion it may be pointed out that, on *a priori* grounds, the inference is logical that the lizards constitute a verruga reservoir. The *Phlebotomus* passes the daylight hours within the darkened recesses of the loose stone walls and piles of rock in order to escape wind and strong light. Lizards inhabit the same places, finding their food there and coming out only briefly at rare intervals to sun themselves. The *Phlebotomus* is always ready to suck blood in the absence of light and wind, and has been found more prone to suck reptilian than mammalian blood. Nothing is more natural than that the *Phlebotomus* should suck the blood of the lizards to a large extent during the day, and this is what actually happens. If the *Phlebotomus* carries verruga, and this is already demonstrated to be the fact, it follows that the lizards must become infected therefrom even if they were not originally so. That they are probably the original reservoir of the disease is indicated in general by the constant host relation which obtains between *Phlebotomus* and reptiles the world over and specifically by the mutual habitat of the two which has resulted in their being thrown continually together since their existence began.

CHARLES H. T. TOWNSEND

CHOSICA, PERU,
April 27, 1914

SPECIAL ARTICLES

ON THE ANTAGONISTIC ACTION OF SALTS AND ANESTHETICS IN INCREASING PERMEABILITY OF FISH EGGS (PRELIMINARY NOTE)

IN previous papers[1] it was shown that pure salt solutions and nicotine increased the permeability of fish eggs and that these permeable eggs developed abnormally, giving rise to cyclopia and other abnormalities common to fish embryos. During the present season I have observed a few cyclopic or one-eyed pike embryos in the hatching jars of the State Fish Hatchery, St. Paul, Minnesota. Eggs of the pike and muskalonge were found to live in water re-distilled in quartz and to be adaptable to permeability experiments. Pike eggs were used, and although they were not as impermeable as Fundulus eggs, they were normally but very slightly permeable to salts. They were placed in distilled water and in solutions of anesthetics or of sodium nitrate, and the chlorides diffusing out of them estimated quantitatively with the nephelometer. Except for the use of the nephelometer, which admitted of a quantitative estimation of very minute quantities of chlorides, the technique was the same as given in the previous papers. If one or more eggs died in an experiment, it was repeated. Pike eggs will live in 3 per cent. alcohol for many days and in 6 per cent. alcohol for a considerable length of time.

Six per cent. alcohol, or $\frac{1}{8}$ saturated (more than 1 per cent.) ether, or $\frac{1}{10}$ molecular sodium nitrate increased the permeability of the eggs. This change was irreversible, but did not kill the eggs—after the eggs were put back into distilled water they remained permeable.

When a salt and an anesthetic were combined in the same solution, it was found that the anesthetic antagonized the action of the salt. This antagonism was not very marked, but seemed to be constant. The method of procedure is shown by the following example: A mass of pike eggs was divided into three exactly equal lots. Lot 1 was placed in 50 c.c. $\frac{1}{10}$ molecular $NaNO_3$. Lot 2 in 50 c.c. $\frac{1}{10}$ molecular $NaNO_3$ containing 3 per cent. alcohol.

[1] McClendon, SCIENCE, N. S., Vol. 38, p. 280; and *Internat. Zeitsch. f. Physik.-Chem. Biologie,* 1914, Vol. 1, p. 28.

Lot 3 in 50 c.c. $\frac{1}{10}$ molecular $NaNO_3$ containing $\frac{1}{2}$ per cent. ether. At the end of eight hours, the water was removed from each lot, evaporated in quartz vessels to 3 c.c. and examined with the nephelometer. The water from lot 2 contained $\frac{1}{2}$, and that from lot 3 contained $\frac{3}{4}$ as much chlorides as that from lot 1.

Two conclusions may be drawn from these experiments.

1. Pure salt solutions or anesthetics, in concentrations approaching the lethal dose, irreversibly increase the permeability.

2. Anesthetics in about $\frac{1}{2}$ the above concentration (which is about the concentration for narcosis) antagonize the action of pure salt solutions, so that the combined action is less than the action of the salt alone in increasing permeability.

It has been shown that the permeability of muscle is increased by stimulation.[2] Anesthetics in certain concentrations tend to inhibit the stimulation of muscle. Perhaps they do so by inhibiting the increase in permeability. This idea is not new, but new facts are brought in support of it.

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June 1, 1914

THE EFFECT OF SOIL CONDITIONS ON THE TASSELS OF MAIZE

Considerable work has been done on the effect of various factors of environment on the growth of the maize plant. Most of these studies have been confined to the pistillate flowers, or the ear, and comparatively little attention has been given to the tassel which produces the pollen.

Lazenby,[1] on studying a number of varieties of corn, showed that the number of flowers upon a stalk varied widely even in the same variety. He also found a certain relation between the number of pistillate and staminate flowers produced by the corn. This relation was not the same for all types.

In work carried on at the Utah Experiment Station by the author and his associates on the effect of soil factors on plants, a study was made of the number of branches produced in the tassels of maize.

The corn was raised at the Greenville experimental farm on a uniform soil that had received no manure for many years previous to beginning this experiment in 1911. There were 36 plats in all, 12 having no manure applied, 12 receiving at the rate of 5 tons to the acre and 12 receiving 15 tons. The size of each plat was 7 x 24 feet.

Each manuring treatment contained six different irrigation treatments of two plats each as follows: (1) no irrigation, (2) 5 inches, (3) 10 inches, (4) 20 inches, (5) 30 inches and (6) 40 inches. The water was applied in irrigations of five inches each. When the plants were a few inches high they were thinned so that each plat contained the same number of plants.

Before harvesting a count was made of the number of branches in the tassel of each plant and averages made for the plats. A record of the number of ears produced on each plat was also made. The work has been carried on for three years. A summary of the results follows:

EFFECT OF MANURE ON THE NUMBER OF BRANCHES PER TASSEL OF MAIZE

Manure Applied	Number Plats Each Year	Number of Branches per Tassel			
		1911	1912	1913	
None...	12	15.45	12.85	13.65	
5 tons..	12	17.29	14.89	18.61	[illegible]
15 tons.	12	18.75	16.09	21.47	18.77

The number of ears produced on each plat was as follows:

Manure Applied	Number of Ears per Plat			
	1911	1912	1913	Average
None........	70	59.25	49.3	59.52
5 tons.......	75	75.41	66.5	72.30
15 tons......	75	78.08	83.5	78.86

[1] Lazenby, W. R., "The Flowering and Pollination of Indian Corn," *Proc. Soc. Prom. Agr. Sci.* (1898), pp. 123–129.

[2] McClendon, *Am. Journal Physiology*, Vol. 29, p. 302.

In order to compare the number of branches per tassel with the ears per plat, 100 was taken as the number on the plats with no manure in each case, and the others expressed in relative numbers.

RELATIVE NUMBER OF BRANCHES PER TASSEL AND EARS PER PLAT

Manure Applied	1911		1912		1913		Average	
	Branches per Tassel	Ears per Plat	Branches per Tassel	Ears per Plat	Branches per Tassel	Ears per Plat	Branches per Tassel	Ears per Plat
None....	100	100	100	100	100	100	100	100
5 tons...	112	107	109	127	129	127	121	121
15 tons.	115	107	125	132	157	160	127	132

The effect of the irrigation water on the number of branches per tassel and the ears per plat is expressed in the following table, which is an average of the three years' results.

EFFECT OF SOIL MOISTURE ON THE NUMBER OF BRANCHES PER TASSEL AND EARS PER PLAT

Water Applied	Number Plats Each Year	Number Branches per Tassel	Number Ears per Plat	Relative Number of	
				Branches per Tassel	Ears per Plat
None.........	6	16.25	69.28	100	100
5 inches.....	6	16.78	76.05	103	110
10 inches...	6	16.33	71.27	101	103
20 inches...	6	16.49	77.38	102	112
30 inches...	6	17.15	73.28	106	106
40 inches...	6	16.56	75.28	102	109

These tables show that the number of branches per tassel is affected by the condition of the soil, and that there is a close relationship between the tassel branches and number of ears produced.

It seems clear, therefore, that the staminate and the pistillate flowers of maize are affected by the same conditions.

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ASCARIS SUUM IN SHEEP

An autopsy of an eight-months-old lamb upon which with others of the same age, a feeding experiment was being conducted revealed the presence of two female ascarids in the small intestine. By the aid of the key in Ransom[1] these were diagnosed as *Ascaris ovis*. These lambs, however, were being fed and kept in pens, previously occupied by hogs, known to be infested with ascarids. The pens had been thoroughly cleaned out before the lambs were placed in them. An examination of the ascarids in the light of this information emphasized their close similarity if not idenity to *Ascaris suum*.

The mothers of these lambs were shipped up from the Carpenter Test Farm in the spring of 1912. No ascarids have ever been found in the sheep on this farm. The examination of the feces of the ewes from which these lambs were raised has never revealed the presence of ascarids. It appears highly probable, therefore, that the lamb got its infestation from the pen in which it was kept and that the eggs from which the worms developed were deposited in the pen by the infested hogs which previously occupied it.

The status of the different species of ascarids affecting man, swine and sheep seems to be somewhat in question. It is considered questionable by some authors whether *Ascaris ovis* (sheep) represents a distinct species, or whether it is simply *Ascaris lumbricoides* (man) or *Ascaris suum* (pig) in an unusual host. Circumstantial evidence in the case here recorded strongly indicates that this statement may be true. It is also questioned by some whether *Ascaris suum* and *Ascaris lumbricoides* represent distinct species. In fact, Neveu-Lemaire[2] does not consider the differences between these worms marked enough to establish a separate species and reduces *Ascaris suum* Goeze, 1872, and *Ascaris suilla* Dujardin, 1845, to synonyms. He calls the ascarids of these two different hosts *Ascaris lumbricoides* Linne, 1758. Feeding experiments may serve to clear up this confusion.

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[1] Ransom, "The Nematodes Parasitic in the Alimentary Tract of Cattle, Sheep and other Ruminants," 1911.

[2] M. Neveu-Lemaire, "Parasitologie des Animaux Domestiques," 1912.

SCIENCE

FRIDAY, AUGUST 14, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NEEDS OF RESEARCH[1]

THE occasion which brings us together to-day is one of profound moment alike to biologists and to the devotees of other branches of science; for in the dedication of your new laboratory we make distinct and formal recognition at once of our existence in a universe chiefly unknown to us and of the most effective method thus far devised for interpreting it. This universe is the complex of phenomena in which we find ourselves and of which we humans form a part, and this method is the method of research. The evolution of our race may be summed up under the two heads of man's relations to and of his means of investigating this complex of phenomena in which he plays the rôle usually of a nameless supernumerary, but occasionally also the rôle of interpreter, or even manager, in an ephemeral presentation of some aspects of the larger drama of life. The event we celebrate, therefore, should stimulate our keenest philosophic interest and rouse our enthusiastic admiration for the favoring circumstances which have made it possible to secure this substantial adjunct to the rare opportunities which have long made Woods Hole a resort for students and investigators in biological science. This event means progress; it marks a definite step in advance along lines of proved advantage to society at large; and it makes additional steps forward easier not only for your organization, but for all similar organizations. Moreover, the age in which we live is preeminently an age of restless, if not

[1] Address read on the occasion of the dedication of the Marine Biological Laboratory, Woods Hole, Massachusetts, July 10, 1914.

impetuous, enquiry, and the development of establishments through which research may be pursued patiently and systematically to demonstrable conclusions is one of the most inspiring signs of our times as well as one of the most essential agencies for the conservation of the best interests of community and national life.

For without the aid of such establishments it is not evident how we may distinguish what is fundamental and advantageous in our advancing evolution from what is accidental or inimical to it. Many eminent minds, indeed, are appalled at the temerity and the impatience of the more radical members of contemporary society in their manifestations of the prevailing spirit of inquiry. Traditions, customs, cherished beliefs and legal methods of procedure are all being challenged. In an era of unparalleled enlightenment so far as available knowledge is concerned we are frequently startled by the fact that there are yet numerous localities where intellectual darkness, if not abysmal ignorance, prevails. In an era of unequaled philanthropy and international amity there are nevertheless instances of wars whose atrocities beggar description, while national armaments which threaten national bankruptcy go forward unimpeded. Although the administration of justice was never on the whole so equitable and so merciful as at present, we are becoming deeply conscious that courts of law so often lead to injustice as to almost warrant the questionable extremes of the "referendum" and the "recall." Thus, also, it is becoming painfully evident that while statesmen and publicists were never so well equipped for their work as at present, they are still pushing political and oratorical methods absurdly far in trying to settle by their aid such complicated questions, for example, as those of tariffs and the diminishing purchasing capacity of the world's monetary standards. Although there never was a time when men of merit received more ready recognition, there are yet those who would seek to divide the earnings and the savings of the industrious and the thrifty with the shiftless and the improvident. And while there never was a time when the rights and the opportunities accorded to women were so numerous and so universal, there are yet members of their sex who, reckless alike of property and life, would destroy laws which society has slowly and laboriously built up through ages of tentative effort and experiment.

This stupendous plexus of conflicting issues, this world-wide phantasm, one might say, of realizable and unrealizable ideas and ideals, may well be a source of despair to the enthusiastic philanthropist, to the hopeful humanist and to the pious religionist; for unless they take into account the secular extent of the time element involved and hence the painful slowness of the processes of evolution, they will not only fail to understand the issues in question, but will fail also to anticipate and to appreciate the improvements to which these issues will lead when fully wrought out. No one unacquainted with the essentials of the Darwinian theory and no one not animated by a patient and painstaking spirit of research can expect to gain anything better than a superficial view of the activities, aims and aspirations of contemporary life. The problems it presents are as much problems in biology, in anthropology and in all of the older branches of physical science, as they are problems in political economy and jurisprudence; although, strange as it may seem, we have hitherto held them to be, and may still expect them to be long commonly considered, problems belonging solely to the provinces of politics and religion. Out of this mixture of wisdom and unwisdom, out of this conflict of opinions of the masses and the

classes, and out of the hopes and the fears of a small minority of contemplative and constructive minds will come the advances to which a healthy optimism bids us look forward. But these advances may be rationally expected to come only slowly and falteringly, with many setbacks, and with direct benefits chiefly for our successors rather than for us; for biological science has taught us that the social organism works in general with extreme deliberation and works for the individual only as a relatively insignificant unit in his race.

And in keeping with this broader view of our relations to the larger part of the universe, the event we celebrate is especially noteworthy not so much by reason of its individuality as by reason of the type it represents and the trend of current thought it helps to express. For important as this center of research undoubtedly has been, and should long continue to be, to biological science in America, it is only one of numerous agencies for research now undergoing rejuvenation or now springing up in various parts of the world. The spirit of stolid conservatism and the spirit of reckless enquiry, alike inimical to the public welfare and to the progress of science, are being replaced in larger and larger degree by a spirit of patient investigation which seeks to substitute constructive for destructive work and to discover how the best interests of mankind may be secured under the inexorable restrictions imposed by that vastly larger part of the universe which we have hitherto so commonly and so blindly ignored. In this conscious effort to discover our relations to the environment in which we find ourselves and in this conscious recognition of the limitations of human existence and endeavor are to be found the most encouraging evidences of progress. We should guard carefully, however, against our instinctive tendencies to accept the widely popular fallacy that what we call research is either novel or of recent origin. Research, as we now understand the word, means simply a systematic application of the methods of science. These methods are as old, certainly, as written history, and they have undergone a tedious and painful development. We may no longer think rationally of the achievements of men as appearing suddenly any more than we may think rationally of other phenomena occurring in violation of the principle of continuity. All such vagaries, though still too common, belong to the Homeric childhood of our race. Neither are these methods the exclusive property or tools of any class or classes of men. What is new with regard to them is an increasing assurance in their validity as a means of truthfully interpreting and hence controlling within determinable limits the conditions of existence on our planet.

But in addition to these generally favorable circumstances for the appreciation and for the promotion of research, circumstances far more propitious, probably, than at any earlier epoch in history, there are many collateral considerations which obviously demand our attention if we are to make good use of the enlarged opportunities now becoming available to us in increasing measure. Along with the extraordinary advances of science and its beneficent applications in the nineteenth century there has come also an equally extraordinary development of private and public confidence in those advances and hence a desire for liberal endowment of research by individuals and by governments. This has been the case in our country especially. Captains of industry, philanthropists and legislators have manifested a spirit of altruism and a degree of foresight quite without parallel in previous experience. An unprecedented amount of funds has recently become available for research, and

this amount appears destined to increase as time goes on. We are thus confronted, in America, at any rate, by a relatively new set of problems for men of science, problems in finance, in administration and in adjustment of mutually helpful relations between novel research establishments and organizations already extant in the fields of education and other forms of altruistic effort. It is to some of the requirements which these problems demand of us as specialists in the domain of science that this address is more particularly devoted. What are the needs of the times, what are our personal duties and responsibilities as workers in science, and how should we seek to forward the improvements essential to further the progress of our race? To these and to allied questions your attention is henceforth invited.

It would appear quite unnecessary before an audience of this kind to further define the meaning of the word research. But it may be instructive to consider for a moment how far the popular mind, and how far many disciplined minds, may depart from the meaning we attach to the term. We should never forget that the investigator lives usually in the presence of majorities which do not understand him and that progress is largely conditioned by these majorities. Thus, to journalists and to their readers it would seem that research is akin to necromancy and that its results are produced chiefly by witches of the male sex, otherwise designated in the polite literature of our day as wizards. Closely akin to this infantile fallacy is the more subtile error entertained by a majority, perhaps, of our highly educated contemporaries, that the more remarkable results of research are produced not by the better balanced minds, but by aberrant types of mind popularly designated by that word of ghostly, if not ghastly, implications, namely, "genius." Out of these misconceptions, which require only the briefest examination for their rejection, arise volumes of fruitless correspondence and many directly serious obstacles to progress. They are evidently part of the intellectual rubbish we have inherited from the remote past; but unfortunately their obvious origin does not prevent well disposed inquirers from raising the questions whether research establishments will undertake investigations which are not scientific and whether they should not give special attention to eccentric rather than to normal minds. A clarification of ideas which will lead to a dissipation of these vagaries is one of the greatest needs of the day.

A similar clarification of ideas in the popular mind is essential to appreciate the distinction between the usual aims of the investigator and the usual aims of the inventor. Investigation and invention are so closely allied that they are often confounded with one another. Indeed, the investigator is often compelled to devise inventions to promote his researches and the inventor is often compelled to make investigations in order to perfect his inventions; while the secretiveness of the inventor has its correlative in the desire of the investigator to secure priority of publication, as in the naming of new species. But in general the objects of the investigator are mainly altruistic while those of the inventor are mainly egoistic; the one seeks to give freely to the world the results of his researches, the other seeks personal benefits by aid of letters-patent. It is plain, therefore, that while there is now room for contemporaneous and probably advantageous public altruistic and private egoistic organizations for the promotion of research, relations of complete reciprocity can not obtain between them. Thus, for example, the U. S. Bureau of Standards is giving the results

of its admirable researches to a multitude of highly productive and praiseworthy commercial organizations; but whether the inventions so promoted and protected by patent laws will result on the whole advantageously to society or to inventors is a question which remains to be determined. It is well known that as a rule inventors are a sadly disappointed class; and when we consider the great waste of effort and resources entailed by patent litigation, it appears plain that the aggregate of rewards arising from the egoism of the inventor is much less than the aggregate of rewards arising from the altruism of the investigator. We may look forward, perhaps, to an epoch of more advanced social development when the functions of patent offices will be abolished except as they may serve to register important improvements and discoveries. In the meantime, altruistic research agencies may not be properly expected to perfect inventions, to secure letters-patent for them, to defend inventors in suits at law or to exploit successful inventions.[2]

Another popular illusion which everywhere retards the evolution of research institutions is more specious and hence more dangerous than those just referred to. It involves all of the fallacies which have thus far rendered the highly developed mathematical theory of probabilities of limited application in the ordinary affairs of life. It manifests itself in various forms, but most commonly finds expression in the notion that research establishments should solicit suggestions, or busy themselves in casting drag-nets in the wide world of thought, or in dredging, as biologists would say, with the expectation that out of the vast slimy miscellanies thus collected there will be found by the aid of a corps of patient examiners some precious sediments of truth. By this method it is assumed that the entire range of possibilities for discovery will be included; and it is likewise assumed that no idea of value can escape the superhuman intelligence attributed to the examiners. There is thus available at last, the argument runs, a comprehensive way to utilize for any given case even the small soul of truth contained in that ancient and cautiously wise aphorism, "there may be something in it"; and the doors are thus opened also to the hosts of amateurs, dilettanti and paradoxers who stand ready to waste the time and the resources of research establishments in the pursuit of the obvious, the futile and the demonstrably unattainable.[3] Two simple facts will suffice to dispel this illusion. The first of these is that important advances in knowledge are far more likely to issue from the expert than from the inexpert in research. Indeed, the probability of extending knowledge by organizations conducted by disciplined investigators is so much greater than the probability of extending knowledge by the drag-net method that we not only may but should ignore the latter in comparison with the former. The second fact is that no competent examiner is willing to spend his energies in raking over the

[2] There is little doubt that an endowed organization, and possibly a state organization, for the promotion of inventions, could now be established with great advantage alike to society and to inventors. There are plenty of able inventors who would be glad to work on salaries and to give as freely to society the results of their labors as investigators do.

[3] Along with the amateurs and the dilettanti, who are not without certain commendable characteristics, there are to be counted also in great numbers cranks, quacks, charlatans, aliens and mountebanks. The paradoxers include especially arc-trisectors, circle-squarers and perpetual-motion men and women. It is amazing how easy it is for an individual of any of these classes to get letters of introduction to research establishments from our otherwise highly esteemed contemporaries.

contents of the drag-net. No more fruitless or thankless task could be assigned to an expert investigator than that of detecting the relatively microscopic quantity of truth to be found in the vast volume of error with which undisciplined minds would eagerly occupy his attention.

But the need of clear ideas on the subject of research is not limited to the majorities of our fellow men who are naturally preoccupied with other affairs. There are vexatious variations of opinion as to what research is, and great diversities of view as to how it may be effectively carried on, held even by its devotees and more especially by its nearest allies in the fields of education. Thus, adventure, exploration, the collection and naming of specimens and the tabulation of bibliographies, any or all of which may be incident to, are not infrequently mistaken for research by those engaged therein or seeking to contribute thereto. Similarly, it is often assumed that research is a harmless and a fruitless diversion in the business of education, and that it requires but a portion of the leisure time of those chiefly occupied with duties of instruction and administration in colleges and universities. On the other hand, some eminent minds maintain that serious and fruitful research can be advantageously pursued only in connection with work of instruction, while a few enthusiasts go so far as to suggest that the mental and the bodily vigor of an investigator can be conserved only in the stimulating presence of immature minds, otherwise known as students or candidates for higher academic degrees. Such eminent minds and enthusiasts entertain grave doubts as to the propriety of the existence independently of colleges and universities of research establishments. It is darkly hinted, indeed, that the latter may work harm, if not ruin, to the former by enticing the effective teacher away from his students and by checking the diffusion in order to promote the advancement of knowledge. Thus it has happened that sinister predictions and panicky sentiments have attended the development of a few research establishments in our own country and abroad during the past decade. We seem to have undergone a sort of intellectual flutter similar in many respects to that more profound emotional disturbance which followed the publication of the ideas of Darwin, Wallace and Spencer, a half century ago, and presaged the extraordinary development of biological science as we know it to-day.

Happily, the untoward features of this more recent agitation, features leading to numerous unrealizable ideals and to numerous necessary disappointments, are now subsiding; and the sense of humor and the sense of proportion so essential to the dissipation of mental aberrations are now regaining the ascendancy. Indeed, after a decade of wild conjecture and extravagant expectation on the part of many men of science and many educators, we may now venture, perhaps, to look squarely at the facts which confront us and to apply the rules of elementary arithmetic with some hope of adequately visualizing the relations which should exist between educational establishments, on the one hand, and research organization, on the other.

Confining attention to our own country, some of the salient facts and figures we need to contrast and to contemplate are the following:

The number of higher, or degree-giving, establishments in the United States is now upwards of six hundred; the aggregate annual income of these is upwards of one hundred millions of dollars; and the number of officials connected with them is upwards of thirty thousand.

On the other hand, the number of independent research organizations in the United States is less than half a dozen; their aggregate annual income is less than two million dollars; and the number of officials primarily connected with them is less than five hundred.

The overwhelming disparity between these figures should assure us that there is no immediate and no prospective danger of the usurpation on the part of the more recent research organizations of the rights, privileges and immunities so long, and in the main so justly, enjoyed by educational establishments. But these arithmetical data go further and serve to dispel other illusions which have much hindered the progress of research during the past decade. They show at a glance why the combined incomes of a few research institutions could not meet the deficiencies even of their nearest allies, to say nothing of meeting the limitless wants of numerous other establishments which have expected likewise to be supplied from the same source. It is probable, of course, that of the large aggregate income of our higher educational institutions only a small fraction is available for the promotion of research. This must certainly be the case if the vast amount of expert testimony available is to be taken at its face value. But here again there appear some obscurities that need clearing up. For, as already indicated, it is claimed by many of our highly esteemed academic colleagues that colleges and universities are not only specially qualified and equipped for the conduct of investigation, but that they are the real ancestral homes of this high calling. They seem to possess all of the desiderata except funds. They are like the farmer who has an abundance of fertile land, but who remains inactive because he lacks capital for the production of crops. And just as we would esteem it permissible to challenge any claim on the part of our farmer that he is an expert in husbandry and that his farm is a natural agricultural experiment station, so must we regard it permissible, if not highly desirable in the interests of progress, to question the claims of our academic colleagues. The simple truth seems to be that research has been and is still rarely regarded by the great majority of academic men and women as anything but an unimportant incident to the principal business of academic life. This principal business is the transmission from generation to generation of acquired learning; and it has been adhered to so generally and so rigorously in the past that until our own time educational institutions might be said, with only slight qualifications, to have been depositories of stationary thought. Moreover, in these days of decreasing pretensions and increasing fulfillments it is incumbent especially on those claiming superior qualifications and facilities for research to bestir themselves in order that they may secure that degree of independence which is indispensable to the effective pursuit of fruitful investigations. It is futile as well as incoherent to argue that the funds of the newer organizations could be better applied by the older ones, since we have not heard of the latter proposing to divide their incomes with the financially embarrassed, but often highly commendable, smaller colleges of the country. But in addition to this patent inconsistency on the part of the protestants there is an obvious and insuperable arithmetical obstacle in the way of an acceptable division of the incomes of a few research organizations amongst a multitude of educational establishments, however worthy and however selected.

All this leads up to a frank submission of the proposition that whatever may prove to be the working relations between research

organizations and educational institutions, they must be relations of reciprocity. This is a proposition which should be of special interest to your organization, since sooner or later you will be compelled to consider it. Trustees of such organizations, it is safe to predict, will not be disposed to surrender their rights or to delegate their duties. In this respect they will doubtless be found to be just like trustees of educational institutions. Biologically the two groups belong to the same genus if not to the same species, and under like circumstances the reactions of either group will be the same as those of the other. And is it not plain that such relations of reciprocity are the only permanently satisfactory relations attainable? The widely spread, if not prevalent, assumption that research establishments are mere disbursing agencies, waiting for suggestions of appropriate ways in which to apply funds, is creditable neither to those who entertain it nor to establishments which accept it. This assumption entails too readily the futilities of amateurism, the dangers of favoritism and all of the inefficiencies due to division of responsibilities and to scattering of resources. Thus, while it is quite true that a majority of the fundamental researches of the past have been accomplished by individuals and that they will continue to be so accomplished in the future, it should nevertheless be the primary purpose of a research institution to institute and to conduct research; to take up especially those larger problems not likely to be solved under other auspices, problems requiring a degree of organized effort and a continuity of purpose surpassing in general the scope and the span of life of any individual investigator. Such institutions, like colleges and universities, should expect to continue their work forever, or, at any rate, so long as they are able to add to the sum of that sort of knowledge which is verifiable and hence permanently useful to mankind.

But "how," it is often asked, and doubtless some of our colleagues here are now raising the query, "are the requirements of the worthy individual investigators in colleges and universities to be supplied?" To understand and to answer this question rationally we need first to learn how to distinguish endowments from incomes and then to appeal to our knowledge of mental arithmetic. An application of this much-neglected branch of an ancient science will quickly show that the income of no single research institution now extant, or likely to be founded, can come anywhere near meeting the wants of the great army of competent investigators now pressing for financial assistance to forward their researches. Indeed, neither in a single institution nor in all of those now existing combined, nor in a score more of such, will there be found sufficient funds to supply the world-wide and rapidly growing demand for them. When we are ready to appreciate these salient numerical facts we shall be able to make the next step essential to relieve at once the straitened conditions under which hosts of worthy investigators are now chafing and to respond more quickly to the urgent demands of society for obviously attainable and desirable improvements dependent on research. This next step should consist, first, in an appeal not solely to a few of the captains of industry and the philanthropists whose wisdom and benevolence have been so conspicuously manifest in our day, but to the entire class of such, whose aggregate number, as long since proved by the experience of charitable, educational and religious organizations, is legion. If a small fraction of the vast aggregate annual expenditures of such organizations were devoted to research

under competent guidance, it would go far towards an understanding and hence an amelioration of the adverse social conditions which have so long roused the sympathies but baffled the judgments of the majorities of our fellow men. And in respect to this appeal it is a most encouraging fact that there are in waiting, so to speak, everywhere in our country, at least, increasing numbers of intelligent men and women ready to endow research as soon as they can find trustees of research funds in whom confidence may be safely reposed.

Secondly, this step in line towards relief should consist in the development of larger opportunities for research and in the collection of corresponding endowments therefor, by universities. They must lose their leadership in research if they are obliged in any considerable degree to depend on other organizations for financial support. They should recognize that the ends of research are not limited to the highly worthy object of fitting candidates for the doctorate degree; and they should recognize that there is the amplest room for the simultaneous existence of educational institutions along with other organizations whose primary purpose is not the diffusion but the enlargement of learning. And in the adjustments now forming between these two classes of establishments there should arise the freest relations of reciprocity, especially as regards individual investigators. Much baseless fear has been expressed lest a few research organizations should rob academic staffs of their ablest men, as if those relations at first slightly unilateral might become increasingly or wholly so. It is of supreme importance to both classes of establishments, and particularly to progress in the immediate future, that eminent men should be free to pass from one to another of these establishments without encountering any administrative or other purely institutional obstacles. In fact, it should be esteemed one of the highest attainable objects of any institution to assist in the production of investigators whom other institutions are glad to offer desirable or superior opportunities.

And thirdly, relief should come in large measure through increasing appropriations of public funds to forward all of those numerous researches essential to the public welfare. These fall mostly in the fields of applied science and are often erroneously assumed to produce only the so-called "practical results" directly aimed at. But every investigator knows that the by-products of such researches are usually quite as important as, and often more important than, their anticipated products. A vast aggregate of such work is now carried on by the United States government, by states and by municipalities; and it should be observed that on the whole this work is well done, in spite of the contemptuous references one sees and hears occasionally to the conduct of scientific work under governmental auspices. In a republic destructive criticism of this sort has little weight, since it carries with it the illogical conclusion that our governors are, as a class, inferior to the citizens who elect them. What we much need in this, as in many allied governmental affairs, is less of destructive criticism founded on the shifting sands of partisan sentiments and more of constructive criticism founded on adequate knowledge of biology and anthropology. As a matter of fact and of justice it must be admitted that the aggregate of high-class work of research accomplished by the bureaus of the United States government in recent decades compares very favorably with the corresponding aggregate accomplished by educational and other establishments of our country during the same period. We who labor in the latter establishments, therefore, have no ade-

quate reason to suppose that our reputations may be much improved by invidious reflections on the methods in science followed by men who happen to live "in Washington." Here again it is useful to remember that we and they belong to the same species.

But in order that any measures of relief and of response to the pressing demands of society may become adequately and progressively effective, certain other requirements of greater importance must be realized. These requirements must be supplied chiefly by men of science. To a far greater extent than ever before the methods and the applications of science are concerned with the daily affairs of domestic, national and international life. Ours is an era of unequalled opportunities in science; but it remains in part, at least, to be demonstrated whether the types of men called scientists, whom it has taken many generations to evolve, are prepared to meet the responsibilities as well as the duties now falling upon them. It is an open secret that as a class doctors in science are on trial, and properly so, in so far as they may suggest remedies for the body politic. In the evolution of society they are a sort of "fourth estate" and the latest in the order of human development. It is not so long ago, quite within the recollection of some here present, when society was guided almost wholly by three other classes typified by the man in the saddle, by the man in the pulpit, and by the man on the bench. The rôle of the man of science as manifested somewhat sensationally to the popular mind, for example, in the conduct of industries, in the control of epidemics and in the construction of the Panama Canal, has been recognized only recently as one of vital importance to communities and to states. It is especially incumbent on us, therefore, at this juncture, to put our scientific houses in order and to be ready to demonstrate the validity of whatever claims we may set up by the production of work which will stand on a basis of verifiable merit. It would be unscientific, and inimical to progress, to ask for easier conditions of entrance into the world's affairs, from which as a class we may no longer advantageously either hold ourselves aloof or be debarred by other classes.

Fortunately, there is now little danger that the prejudice and the ignorance which provoked so many wordy wars and so long contested the advent of the "fourth estate," will exert anything like such sinister influences in the future as they have exerted in the past. Science is ever ready and willing to settle matters in dispute by the arbitrament of demonstration, and the conclusiveness as well as the fairness of this procedure is now nearly universally conceded. Indeed, the effectiveness of the methods of science is now not only generally recognized within each of the older "estates" just referred to, but even the more conservative members therein are making and projecting scientific researches with a degree of enthusiasm which compels our admiration. The dangers which beset us are rather dangers of popular over-confidence in our methods, of amateurism and dilettantism and of premature generalizations. The prevailing optimism needs to be chastened by the reflection that the millennium is not in sight, that sound research means arduous enterprise and that advances in knowledge come, as a rule, only after prolonged and even painful effort. In the meantime, while guarding carefully against these dangers, it is the part of wisdom to take every legitimate advantage of the present highly favorable attitude of our contemporaries towards research. We of the "fourth estate" need especially to fraternize with our colleagues

of the other three "estates" and likewise with the still larger and equally favorably disposed groups of our contemporaries in the world of trade, commerce and industry. It is well for us to study them lest we should misunderstand them. We need their aid now more than they need ours; and it should be borne in mind that when any proposition is to be voted upon they are overwhelmingly more numerous.

Time does not permit more than passing reference to the important but as yet little studied subject of research publications, their proper distribution and their adequate popularization; nor to the more important, though less debatable, subject of administration, including what are too often contemptuously regarded by men of science as unattractive if not unessential details of fiscal business; nor to the still more important and complex but little understood subject of boards of trustees, the best methods of choosing them and their proper relations to research organizations.[4] It must suffice here to call attention to them, among many other subjects, as specially in need of patient investigation by men of science. They are subjects, however, whose elucidation may be deferred. An adequate understanding of them will come, apparently, only after the more elementary considerations already dwelt upon are visualized and appreciated. Passing these considerations rapidly in review, the salient needs of research and some of their numerous corollaries may be advantageously summarized in paraphrase and in aphorism even at the risk of apparent dogmatism:

We need first to recognize that in its inclusive aspects research is in scope coextensive with the universe of which we form an insignificant part, but in which we are obliged to play the significant rôle of interpreters if we would make the best of our opportunities. The experience of our race has demonstrated that by study and hence by understanding of this universe the roads to progress may be found. The methods of research are the methods of science. They are not of recent origin. They have undergone an evolution extending far backwards towards the era of primitive man. What is new about them is a widely general and rapidly increasing recognition of them as the most trustworthy methods man has devised for the discovery of truth and for the eradication of error. Along with this recognition there has gone on, and is still going on, a gradual elimination of Homeric illusions and fallacies; so that male as well as female witches must be abandoned by all except the more atavistic, while the appellation "genius" in the singular as well as in the plural is becoming one of doubtful compliment. We are coming to understand also that while there may occur flashes of wit, and even of wisdom, from abnormal types of mind, the more effective emanations of both wit and wisdom are to be expected from normal and patiently contemplative types. And thus the more striking results of research, quite commonly in the past attributed to wizards and to genii, and still so attributed by a majority, probably, of contemporary writers for the popular press, are now understood by the thoughtful to be products rather of industry, sanity and prolonged labor than of any superhuman faculties.

Out of this rational appreciation of the methods of science have arisen quite natu-

[4] An important contribution to this subject has been made by President Eliot in his volume on University Administration (Houghton Mifflin Company, 1908). All such works, however, are generally held to be "too theoretical" by the average man who prides himself on being "practical." In his assumed freedom from theory he often adopts the obviously erroneous theory that there is no room for progress or improvement in the conduct of such affairs.

rally, but relatively suddenly, unprecedented demands for research, on the one hand from communities and states, and on the other hand from academies, societies, institutes and universities. We should observe, however, that this intellectual uprising dates back at least a half century, to about the time when your science was emerging from the limbo of "natural history" in which it had been left to slumber by Pliny the elder. It is part of the general uprising of the nineteenth century of which the multiplication and fruitful activity of scientific societies in America is another surprising and gratifying manifestation. Quite naturally, also, along with this greatly enlarged appreciation of the value and desirability of research there has come a corresponding demand for enlarged facilities and particularly for funds. This demand, like most unanticipated demands, is in the aggregate vastly greater than the present or possible supply, but not greater than can be met if pruned of its adventitious appendages. Research and research organizations are somewhat in danger of being swamped by an excess of symbiosis.

In these circumstances there is constant need of the caution and the deliberation which distinguish scientific investigation from impulsive and emotional mental conduct. We should frequently recall that the characteristic defect even of deliberative bodies is lack of deliberation. We need constantly to apply our well-known methods of research to the questions confronting us. Instead of following precedent, we should in general avoid it. When, for example, a research fund is established we should not make haste in academic fashion to set up poor-boy scholarships and roving fellowships to be awarded to the amateur and to the tyro, but we should seek to originate and to conduct research under the auspices of competent and responsible investigators. And as regards research in academic circles, we need to fix attention rather on the professors who are qualified to extend the boundaries of knowledge than on their pupils. These latter, if worthy of the name, will require little formal instruction in the presence of evolving discoveries and advances; moreover, they must learn early to think with their own heads if they may hope to become either competent teachers or leaders in work of research.

And finally, men of science, if they are to meet the requirements now demanded of them, need more of contact with, experience in and sympathy for, ordinary business life. We are as a class of too recent monastic descent to fit comfortably in our present social environment. The man of affairs does not understand us, and hence often looks upon us with suspicion or even with contempt. He is generally sure that the man of science can know little of finance and of other affairs vaguely emphasized by the adjective "practical." Argument concerning this matter is idle in the face of existing conditions which determine majorities in boards of trustees and in legislative assemblies. Nor would it be the part of wisdom to change abruptly if we could the present course of evolution in affairs of administration. We need to accept the situation as we find it and to qualify for gradual entrance into, and participation in, the details of this ordinary life. It will not be taken for granted, for example, that we can keep accounts and live within income, but a positive demonstration will be accepted without protest. It may be easily shown to our satisfaction by *a priori* reasoning that men of science are no more likely to wreck corporations than financiers, general managers or promoters, but proof by numerous concrete examples must be forthcoming from us. And in proving capacity for trustworthiness in these, to us,

new fields we should avoid the manifest errors of our business predecessors. Agreeing with Dr. Johnson's astronomer that "the memory of mischief is no desirable fame," we should not seek, for example, to perform the academic feat of capitalizing deficits. Even if there were a body of alumni to which appeal might be made in distress, such a feat would be unworthy of a research organization. Above all, research organizations should embrace the great advantages that come from open audit and truthful publicity in all financial affairs. We should accept these and the other conditions and limitations of our environment to which attention has been called, not in a spirit of unreflective meekness, nor in a spirit of impatient defiance, but in a spirit of philosophic equanimity, confident that the scientific methods of observation, experiment, comparison, demonstration, generalization and verification will ultimately work out adjustments to the permanent advantage of our successors, if not to the ephemeral advantage of ourselves.

R. S. Woodward

ADDRESSES AT THE DEDICATION OF THE NEW BUILDINGS OF THE MARINE BIOLOGICAL LABORATORY[1]

The subject of biology possesses immense significance for human thought and action. If the biology, the sociology, the philosophy and whole mode of thought of the twentieth century differ quite radically from those of the mid-nineteenth century, it is largely because the biological investigations of Lamarck, of Darwin and of many others founded the evolution theory, the future development of which is one of the main problems of biology.

The cell-theory, another great generalization of biology, revolutionized the study of pathology, the basis of medicine, besides furnishing the indispensable foundation for all future biological studies. The conception of the physico-chemical constitution of protoplasm, or living matter, is a third great contribution of biological science of inestimable significance for science and philosophy.

Biology is related to the most practical affairs of life: to medicine, of which it forms the indispensable foundation, to hygiene and public health, to many problems of agriculture and animal industry, and to fisheries problems. Economic entomology, parasitology, protozoology, etc., are practical branches of our great subject; not to mention the fundamental principles of the mooted subject of eugenics. The advancement of biology is one of the most important considerations of modern society.

Even such an intentionally incomplete statement of the significance of biology may appear exaggerated. But nothing is more sure than that the acquisition of knowledge increases man's control of nature, and that the science of biology, although still in an early stage of its development, promises control of those uncertainties of practical human life which are most perplexing and dangerous to the race.

The significance of the present occasion is to be found only partly in such general considerations. This laboratory represents one of the forces that have to be reckoned with in this general situation. But it is to the special significance of this occasion that I would more particularly direct your attention.

The sea-shore is undoubtedly the ideal situation for a biological station, because marine life offers certain valuable opportunities for study that are unique. These are given in such a situation as ours, and we relinquish none of the opportunities of inland laboratories. Louis Agassiz, in America, and Anton Dohrn, in Europe, were among the first to organize seaside laboratories; about the same time, 1872, Agassiz founded his station on the

[1] In addition to these shorter addresses and the address of Dr. R. S. Woodward, printed above, an address was made by Professor Edwin G. Conklin, of Princeton University, who, on account of his absence from the country, was unable to prepare it for publication. Mr. C. R. Crane, president of the board of trustees and donor of the building, presided and presented the speakers.

neighboring island of Penikese, and Dohrn his station in Naples.

This laboratory is in a very real sense a lineal descendent of Agassiz's station. Our immediate predecessor was the Annisquam Laboratory organized to serve the same ends as the Penikese school, and the forces there were supplemented and transferred to Woods Hole in 1888.

It is not sufficient that a laboratory should merely be established and equipped. It must be properly organized and manned. In some respects our laboratory has an unusual form of organization. As Mr. Crane has well said, freedom is its dominant character; the freedom of a democracy of learning. Our corporation, numbering 300, extends into a large proportion of the institutions of learning of the country. Our board of trustees, chosen by the corporation, includes representatives of various branches of the biological sciences in many of our leading institutions. The laboratory is owned and controlled by the people whom it serves; and this is the essence of a democratic organization, the only assurance of freedom of development.

The laboratory thus organized stands for the advancement of the biological sciences by research and by teaching. We have not believed it wise to divorce these two functions of learning. The research creates an atmosphere in which teaching is most vital, and the teaching humanizes the research by bringing it constantly in contact with the needs of students, besides serving the essential function of training future investigators.

Freedom of organization is our one watchword. Cooperation is our other. Both are vital, and they are interdependent. When people are free those of similar interests naturally cooperate, so long as they respect freedom. And so we have a union of forces of scientific men, and through them of institutions that they represent in order to create conditions as ideal as possible for the progress of science.

The new building stands for a certain stage reached in the evolution of this democratic institution; it stands for recognition of a certain degree of demonstrated stability; and for a certain amount of assurance of permanence. And so we rejoice in the present occasion, and have asked many of our friends to join with us in dedicating this building to the ideals of research, of teaching and of cooperation in freedom of spirit.

This magnificent building which we dedicate to-day is the most efficient instrument of research in the hands of biologists. For its beauty and enduring strength we are indebted to the great architect, Charles Coolidge, who rendered his services freely; and for its convenience, adaptability and sufficiency to Dr. Drew, with whom the perfection of every detail has been a labor of love.

We must not forget on this occasion to honor the memory of our greatest leader, Professor Whitman. I would that he had lived to see this day; and, as he valued the things of the spirit so infinitely above the material, I hope that he would find that the spirit of the present stage of our institution matches its material equipment.

R. S. Lillie

I appreciate the courtesy that has been extended to me by the invitation to attend these exercises. I have gladly accepted that invitation on behalf of the bureau I represent, because I feel it to be a pleasure that may properly be enjoyed and a duty that should not be neglected, to testify by my presence and words to the interest which the Bureau of Fisheries has in the opening of this new building and in the larger field of usefulness which is hereby presented to the Marine Biological Laboratory.

From Secretary Redfield I bring a cordial message carrying hearty congratulations, appreciation of the spirit which has actuated the donation of this magnificent edifice, sympathy with the past and future work of this institution, and the assurance of his desire to have the scientific activities of his department, here and elsewhere, in genuine cooperation with and in aid of biological research.

My dominant thoughts on this occasion are of those who once labored here but are no longer with us. I have been thinking of the satisfaction with which they would have en-

tered into this day's exercises. I need not name all of them, but I recall, as you will, Peck, Ryder, Montgomery, Gardiner, and especially Whitman; and one other, the pioneer who really discovered the biological advantages of Woods Hole as early as 1869, and did as much as any one else to inaugurate the movement which has made this the most noteworthy American center for marine biological research. I refer, of course, to Spencer F. Baird.

I have been asked to speak of the cooperation that should exist between the Bureau of Fisheries and the biologists and their institutions; but that is too large a subject to handle adequately in the few minutes that have been allotted to me.

It is perhaps quite unnecessary for me to state that the Bureau of Fisheries is always ready to lend to biologists substantial aid and effective cooperation compatible with its functions and with the purposes for which it receives support from congress. The various phases of this cooperation need not be mentioned, but there may be cited, as an example, the scientific expeditions to which the *Albatross* was assigned, under Agassiz, Jordan and others, which have resulted in larger additions to knowledge of the life of the sea than have come from any other source, not even excepting the *Challenger*.

On the other hand, many of the leading biologists of the country have rendered noteworthy service to the bureau in investigating fishery and cognate subjects. In the capacity of investigators for the bureau or as the recipients of the courtesies at its laboratories, on its vessels, or in the field, a very large proportion of the prominent American biologists of the last quarter of a century have cooperated in the furtherance of science. At the present moment we are favored by cooperative relations with the representatives of the biological departments of 10 state universities and of as many other front-rank universities, to say nothing of various other institutions of learning.

I will take this opportunity to call attention to the fact that, in addition to the two marine fisheries laboratories now maintained by the Bureau at Woods Hole and Beaufort, it is expected that during the next year work will be commenced on a third marine biological station, to be located at or near Key West, where the wonderful fauna of the Gulf Stream and of the abysses over which it flows, and of the coral reefs and the shoal waters back of them, will furnish unrivaled opportunities for research. Furthermore, if a bill now before congress should become a law, a fourth station will be established on a site which will render accessible for study under government auspices one of the rich biological regions of the Pacific coast.

During the present summer there has been opened a fresh-water biological station, located on the Mississippi River at Fairport, Iowa. It has a large laboratory building, an abundant supply of crude and filtered river water, an extensive pond system and a general equipment that should render it an important factor in the study of the biology of the waters of the Mississippi Valley.

All of these laboratories are, or will be, freely open to qualified men of science, under such restrictions only as are required by good administration.

Here at Woods Hole, the friendly relations that already exist should be extended. The two laboratories have different functions and occupy different fields. There is no reason why any feeling of rivalry should exist. There is every reason why mutually helpful and close cooperation should prevail. Mention may be made of some of the ways in which the two institutions may profitably work together:

(*a*) Exchange of material where research is being conducted on a given subject at one laboratory and not at the other. For instance, the Bureau of Fisheries is now conducting at Beaufort, and will conduct next summer at Woods Hole, a comprehensive study of the post-embryonic development of economic fishes, a very important subject to which practically no attention has heretofore been given. Suitable material obtained by the Marine Biological Laboratory in its towings and otherwise would be valuable and most acceptable.

(*b*) Exchange of information between the directors concerning the subjects under investigation at the respective laboratories, with the view to prevent duplication of work, but particularly to advantageously supplement at one laboratory work which in some of its phases may be under way at the other. For instance, certain work at the Marine Biological Laboratory may have economic connections which would not be given much consideration. Probably an investigator at the Fisheries Laboratory could be assigned to this side of the subject to the mutual advantage of both workers, economy of material and effectiveness of effort. Conversely, while the Fisheries Laboratory is concerned with investigations more directly related to the fishing industry, there frequently arise in connection with them collateral, more abstract, problems which would perhaps appeal to investigators at the Marine Biological Laboratory.

(*c*) Reciprocal access to daily collections. It frequently occurs that when no one at a laboratory has an interest in a certain organism, or classes of organisms, the material collected is either thrown away or imperfectly cared for. If when the collections are brought in a competent person from the other laboratory, and familiar with its needs, could be given an opportunity to examine the collections, or at least the rejected material, much now wasted might be utilized.

(*d*) The effectiveness of the collecting could probably be increased by such cooperation as would prevent duplication in the fields covered. This could be arranged by an understanding of mutual requirements and the cooperation of the collectors.

I share the feeling entertained by many others that a new era in American biological science is now dawning; and that, under the inspiration and stimulus afforded by Mr. Crane's noble gift, the day is not far distant when Woods Hole will come to be generally recognized abroad as well as at home as the world's biological Mecca.

Hugh M. Smith

TIME RATIOS IN THE EVOLUTION OF MAMMALIAN PHYLA. A CONTRIBUTION TO THE PROBLEM OF THE AGE OF THE EARTH

Considered as a historic science, geology has not yet solved its first problem. There is as yet no satisfactory way of estimating the age of the earth and the length of geologic periods. The various methods that have been devised to compute it are all subject to such large factors of uncertainty dependent upon questionable assumptions, that the most that can be claimed for them is that they indicate the order of figures which should be assigned as the antiquity of geologic periods. The relative length of the periods one with another can usually be more definitely gauged. But the translation into years is a matter of wide divergence of opinion and no real proof that any of the results are even approximately correct.

It is quite true that various estimates have been made by geologists and physicists resulting in figures which are of the same order of magnitude and in reasonably close agreement, although derived from independent sources. This might be taken as evidence that the age probably lies within these limits. But in fact it does not prove any such thing, for it rests in every case upon the assumption that the activities, whose accumulated results are the measure of the length of time that they have been in action, have proceeded in past times at the same pace as at present. This is not only unproved, there are strong reasons for believing it widely different from the fact.

There is no occasion to review these methods of computation or to point out other unprovable assumptions. Every competent discussion of the subject has sufficiently called attention to them.

What I have to contribute is the suggestion of a possible measure derived not from inorganic, but from organic evolution. It is approximate indeed, and relative, based like the others upon assumptions which can not be proven. But it is perhaps—I dare not say more—free or partially free from subjection to the varying intensity of inorganic activities

which vitiates in common all calculations based upon the assumption of their constancy.

In working upon the numerous phyla of vertebrate animals, especially of mammals whose evolution is recorded in our Western Tertiaries, I have been impressed with the fact that they seem to have a fairly constant maximum rate of progressive evolution. The rate of alteration in structures that are being changed adaptively to some changing environment or habit is fairly uniform, comparing one phylum with another. Where concentrated upon one element of change or a few, it is more rapid; when distributed into a great number of alterations of a complex structure it is slow. Some structures are much slower to change than others—notably this is true of the teeth as compared with the bones of the skeleton.

It is essentially a constant progressive change. Where we find sudden jumps of any considerable magnitude the explanation is always at hand, and usually obvious when the circumstances are studied judicially, that we are dealing with an imperfect record, and the breaks are due to migration or to unrecorded lapse of time. To prove this point—a disputed one, I am well aware—would take me too far afield. I must rest on the assertion that twenty years study, in field and laboratory, of American fossil mammals, has brought me to the conclusion that the evolution of their phyla took place through the cumulation of minute increments of structural change, at a rate which, whether concentrated upon one feature or distributed over many, presents some approach to a uniform maximum.

I fully believe that the change is due to the pressure of the environment, acting through selection upon individual variations. Whether these be mendelian or fluctuative in their law of transmission is immaterial. The point is that they are minute, well within the limits of a species as conservative paleontologists draw those limits.

If they are accumulated through selective action of the environment, how can they be said to be in any sense free from the varying rate of change of inorganic activities which vitiate calculations based upon the constancy of their action. If the environment is changing rapidly at one time, slowly at another, will not this be reflected in the rate of change of any phylum of living beings? Undeniably this is true. Yet there does appear to be a maximum rate of change as above outlined, and environmental change exceeding that limit results in migration and extinction, not in structural alteration. Moreover, a large part of the structural evolution which we can observe must be in reaction to the pressure of the biotic, not the physical environment. A large portion of the progressive structural change is advantageous to the animal under any circumstances, whether or not the physical environment changes. This is peculiarly true of increase in brain capacity; it is partly true of increase in mechanical perfection of the structure leading to increased speed, better tooth mechanism as well as numerous changes not recorded in the skeleton.

It would seem therefore that there is a maximum rate at which alterations in the structure can take place. I suppose this rate to be conditioned by two factors, individual variability in the organism, and selective processes under the conditions obtaining in nature. At all events the fact stands as of record, proved and confirmed by innumerable instances, that the evolution of any direct phylum does take place through cumulation of minute changes, at a rate which, allowing for concentration upon one element of change or dispersal over many, does present a considerable degree of uniformity in corresponding parts, whether of the same phylum at different times or of different phyla at the same time. This rate may often not be attained, but I can find no convincing evidence that it can be exceeded.

The amount, variety and fundamental character of the differences thus accumulated are the practical measure of our systematic classification. A difference or group of differences of small amount, yet distinctly beyond the limits of individual variation, is customarily regarded as specific. Differences of a decidedly larger order are considered generic, and so on. It would perhaps be a fair average estimate

to say that one genus differs from the next ten times as widely or fundamentally as one species from its next neighbor. There is no sort of exact rule in the matter, but this would perhaps represent the average opinion to which each systematist endeavors to conform in arranging the group upon which he is working.

Now if the above conclusions are warranted we may find in the recorded evolution of various well-known phyla a rough measure of the relative length of the epochs covered by its evolution. In instance we may take the evolution of the horse. This phylum as represented in the American Tertiaries I believe to be a direct phylum so far as the genera are concerned; the relation of the species to the direct line of descent are mostly immaterial to the present discussion.

Equidæ (Direct Phylum)	Relative Amount of Structural Difference from Preceding Stage	Geologic Epochs
Equus caballus, etc.	1	Recent
Equus scotti, etc.	10	Pleistocene
Hipparion	10	Pliocene
Merychippus	15	Miocene
Parahippus	5	
Miohippus	5	Oligocene
Mesohippus	15	
Epihippus	10	
Orohippus	10	Eocene
Eohippus		
		Paleocene

It would be possible to verify these estimates of structural differences by comparative measurements. But it would be an enormous task. To select a few of the great number of structural differences for measurement would be almost certainly misleading; to average them all would entail many thousands of measurements for each species or genus compared. The final result might be twice as much or half as much as the estimate I have given; it would certainly not be ten times or one tenth as great. The margin of error for each estimate here given is not to any great extent cumulative for the whole series. The errors would therefore tend to balance to some extent, and the margin of error for the whole series would be less in proportion. For these reasons, and because of the doubt already expressed as to whether the maximum rate of evolution is really a constant, I have not thought it worth while to verify the estimates by measurements.

From the beginning of the Pleistocene to the present time, the evolutionary change in the phylum is measured by the difference between the modern species and the nearly allied species found in the Aftonian and other equivalent formations of early interglacial time. During the Pleistocene there has been a great deal of migration and shifting of faunas; the actual evolutionary change in this or any other mammalian phylum is notably small. It is perhaps one tenth the amount of structural change that separates *Equus* from *Hipparion* of the late Miocene and early Pliocene. *Hipparion* in turn differs about as much from *Merychippus* as it does from *Equus;* the estimated structural difference between the earlier stages is represented by the remaining figures in the column. Adding up these figures, we find that the amount of structural change in the *Equus phylum* during the Tertiary is 85 times the amount of Pleistocene evolution. So far as this is a measure of geologic time, it means that the Tertiary from Suessonian upward was 85 times as long a period as the Pleistocene. To this should be added a considerable figure for the Paleocene, whose length based on the evolution of other phyla might be assumed at 10 or 15 times the length of the Pleistocene. Briefly then, on this basis we should assume that the entire Tertiary is about 100 times as long as the Pleistocene, dating the latter from the first great glacial advance.

This is greatly in excess of the proportion usually assigned. But the Pleistocene was a time of extreme activity in sedimentation, denudation and other inorganic activities whose rate affords the basis of the various calculations that have been made. The amount of Pleistocene denudation, the thickness of its sediments, would hence give a greatly exaggerated measure of its length in time as compared with the whole of the Cenozoic.

The various other phyla of mammals support these proportions fairly closely. None are

quite so complete, direct and obvious in their structural change as the Equidæ. But the results obtained by a careful consideration of the phyla of Camelidæ, Rhinoceridæ, Tapiridæ, Canidæ, etc., do not appear to me to differ materially.

It is only in a very general and tentative way that we can apply these standards to the Mesozoic. A comparison of the amount of evolution in vertebrates between the end of the Permian and the end of the Cretaceous in comparison with the maximum change from the end of the Cretaceous to the present day, gives in turn the impression of a distinctly higher order and more fundamental quality of change. My impression would be that each of its four periods, Triassic, Jurassic, Comanchic, Cretacic witnessed structural changes in vertebrate phyla as extensive and profound as those that took place in the Mammalian phyla during the Tertiary. As to the Palæozoic, I have no basis for an opinion. It should be remembered that it is the maximum rate of change that is used as a measure. Many races, more often many characters in a race, changed slowly or not perceptibly.

It will be obvious that, if these proportions hold true, an estimate of the length of the Pleistocene will afford a measure of the length of the Tertiary and older periods in years. But the estimates of Pleistocene time differ enormously. The lowest estimate is perhaps by G. F. Wright, who will not allow more than 25,000 years. At the other extreme stand Penck and other authorities with estimates of 1,500,000 years or more. The more moderate figures of 50,000 to 200,000 years generally adopted seem more probable than either extreme. According to the proportions above estimated of Tertiary to Pleistocene time, we should have

Pleistocene	Tertiary	Mezozoic
25,500 years (Wright)	2½ million	10 million
100,000 years (Walcott)	10 million	40 million
1,500,000 years (Penck)	150 million	600 million

If the proportions usually assigned to the Paleozoic be correct, it was as long as or longer than Mesozoic and Tertiary combined. This would give twenty-five million years for the whole of the fossiliferous record upon the extreme figures of Professor Wright; on Walcott's estimate over 100 million, and on Penck's over 1,500 million years. For various reasons I am disposed to believe that the relative length of the Paleozoic should be revised upward, but the estimate of ten million years for the Tertiary and forty for the Mesozoic does not seem unreasonable.

W. D. Matthew

American Museum of Natural History

SCIENTIFIC NOTES AND NEWS

Among the large numbers of American scientific men and university professors now detained on the continent and in England, probably the most serious inconvenience is suffered by the surgeons who attended the recent congress in London, some nine hundred of whom are said to be unable to obtain passage home. The only serious difficulty so far reported is the arrest and imprisonment of Mr. and Mrs. Archer M. Huntington in Nuremburg, Bavaria. Mr. Huntington is president of the American Geographical Society, and it is said was making a study of aeronautical routes.

Professor Elie Metchnikoff, assistant director of the Institut Pasteur, will next year celebrate his seventieth birthday and the fiftieth anniversary of his doctorate. A committee has been formed, under the presidency of Dr. Roux, director of the Institut Pasteur, for the celebration of the anniversary which will include the publication of a "Festschrift."

Mr. Marconi has had the order of the Honorary Grand Cross of the Victorian Order conferred upon him.

Among those upon whom the University of Aberdeen conferred honorary degrees at the recent meeting of the British Medical Association were Mr. W. T. Hayward, Mr. T. J. Verrall, Sir Victor Horsley, Dr. Archibald Garrod and Sir John Bland-Sutton.

The first presentation of the Saville medal, established by the West End Hospital of Nervous Diseases, London, in memory of the late

Dr. T. D. Saville, has been presented to Dr. Knowles Boney.

Mr. A. T. Bradlee has been awarded the medal offered by the National Association of Cotton Manufacturers for investigations upon the effects of moisture in testing cotton yarns and fabrics.

In addition to those already named in Science Dr. C. G. Abbot, director of the astrophysical observatory of the Smithsonian Institution, will attend the Australasian meeting of the British Association as the guest of the New Zealand government.

The foreign medical men who attended the Aberdeen meeting of the British Medical Association included: Professor Stéphane Leduc of Nantes; Dr. E. Pontoppidan, professor of medical jurisprudence at Copenhagen; Dr. Clemens von Pirquet, professor of pediatrics at Vienna; Dr. Umberto Gabbi, professor of tropical medicine at the University of Rome; Dr. Karl Jung, professor of psychiatry at the University of Zürich; Dr. Alban Bergonié, professor of biological physics at the University of Bordeaux; Dr. H. Morestin, professor of surgery in the University of Paris; Dr. Rist, professor of clinical medicine in the same university; Dr. Fritz Frank, professor of midwifery at Cologne; Professor D. S. Demetriades, of Athens; Professor Adolf Onodi, the laryngologist of Budapest, and Dr. J. R. Macleod, professor of physiology, Western Reserve University.

Mr. Watson Nightingale, B.S. (Mass. Inst., '14), has been sent by the Bureau of Fisheries to make a series of microscopic observations of plant and animal life on the Grand Banks off the coast of Labrador.

Messrs. F. E. Matthes and F. C. Calkins, of the U. S. Geological Survey, have returned to the Yosemite region, in California, to resume the geological and geographical studies they began last year.

The American Museum of Natural History has sent two expeditions from the department of vertebrate paleontology, the first in charge of Mr. Barnum Brown, to the Red Deer River of Alberta, Canada, to collect Cretaceous dinosaurs, and the second, in charge of Mr. Albert Thomson to Agate, Nebraska, to secure additional *Moropus* skeletons.

Professor J. C. Bose, of Calcutta, will deliver a lecture before the Royal Society of Medicine, London, on October 30, on the modification of response in plants under the action of drugs.

The biennial Huxley lecture will be delivered by Sir Ronald Ross, K.C.B., F.R.S., at the Charing Cross Hospital Medical School on October 1.

We learn from *Nature* that it was decided at a meeting of alpinists held at Zermatt on July 25 to commemorate the fiftieth anniversary of the first ascent of the Matterhorn (falling on July 14 next) by the erection of a marble statue of Mr. Edward Whymper at the age he was when he first climbed the Matterhorn. The pedestal is to be of granite taken from the Matterhorn and the monument is to face the peak. The memorial will also commemorate Lord Francis Douglas, Mr. Hadow, the Rev. C. Hudson, and the guides, Michel Croz and the two Tangwalders. The cost will be borne by subscriptions. Mr. Justice Pickford, president of the Alpine Club, is to be invited to become the honorary president of the memorial committee. Dr. A. Seiler was appointed treasurer, and Mr. J. Grande, of Berne, honorary secretary.

The death is announced of the Rev. Dr. Stephen D. Peet, editor of the *American Antiquarian and Oriental Journal,* which he established in 1878 and conducted for thirty-two years.

Dr. R. J. Anderson, professor of natural history and geology at University College, Galway, has died at the age of sixty-five years.

The Russian government's ice breaking steamer *Taimyr* arrived at Nome, Alaska, on August 4, and left the following day for Wrangell Island to take off the twenty-one men who found refuge there after the wrecking of the Stefansson exploring ship *Karluk* in the ice north of Herald Island last January. The United States revenue cutter *Bear* sailed for Wrangell Island via Point Barrow on

July 21. After she sailed news was received that the ice about Wrangell Island was unusually firm, and the Russian government decided to send the powerful *Taimyr,* which can cut a way where the wooden *Bear* would be helpless.

According to its program, the ninety-seventh annual meeting of the Swiss Scientific Association will be held at Berne, on August 31 to September 3. The general addresses include: "The Influence of Natural Science on Modern Medicine," by Professor H. Sahli, of Berne; "The Synthetic Dyes," by Professor Noelting, of Mühlhausen, and "The Primates of the New World," by Dr. H. Bluntschild, of Zürich. The association meets in nine sections for the reading of special papers.

We learn from the *Journal* of the American Medical Association that an international school hygiene congress will be held in Brussels next year. The program takes up the following subjects: school buildings and equipment; medical inspection of urban and rural schools; prevention of contagious diseases in schools; the teaching of hygiene to teachers and parents; school hygiene in its relation to physical education of children; methods, syllabuses and school equipment in their relation to school hygiene; school hygiene in its relation to the children, and school hygiene in its relation to adolescents. The congress is under the patronage of the King of Belgium, and under the auspices of the National Institute of Pediology and the Belgian Pedotechnic Institute. The committee of organization is presided over by M. J. Corman, director general department of sciences and art, and Dr. J. Demoor, director of the Free Institute in Brussels.

According to the *Bulletin* of the American Geographical Society a large relief model of the Yosemite Valley is being constructed at the Office of Public Roads in Washington for the government exhibit at the Panama-Pacific Exposition. It is twelve feet long, six feet wide and carries relief to a height of 18 inches. The vertical dimension is not exaggerated, and as a consequence all features are shown in their correct proportions. Indeed, so rugged is the topography of the Yosemite Valley, that any increase in the vertical scale would have resulted in a peculiar, distorted appearance of the great cliffs, domes and spires. The model is being executed, with painstaking exactness, by an expert model maker, and is based upon the detailed topographic map of the Yosemite Valley, prepared in 1905–06 by Mr. F. E. Matthes, of the United States Geological Survey. Portions of this map were enlarged photographically to five times the original scale, that is, to a scale of 440 feet to the inch. The contour lines then were used as patterns for the sawing out of thin wooden boards. These boards were built up in layers and the rough form thus obtained was plastered over with a special preparation of great durability that will bear transportation across the continent. Large numbers of photographs are being used for local details, and a special effort is being made to reproduce with fidelity the peculiar cliff sculpture which is so prominent a factor in the Yosemite landscape. Inasmuch as these sculptural forms are intimately associated with the lines of structure in the granites in which the valley lies hewn, the model promises to become an unusually fine medium for the study of these relations of form to structure. Students of geology and geography will therefore, in all likelihood, find it an object worthy of a special visit at the San Francisco Exposition. Explanatory legends will be placed on the sides of the case at various places, directing attention to the most interesting features. In order to heighten the sense of reality, small streams of water, blown to spray by atomizers, will represent the waterfalls.

The committee appointed by the Paris Academy of Sciences to allocate the amount placed at its disposal by Prince Bonaparte is reported by *Nature* to have made the following proposals for grants during 1914: 2,000 francs to Dr. Pierre Breteau, for the continuation of his researches on the use of palladium in analysis and organic chemistry; 2,000 francs to M. Chatton, to enable him to continue his researches on the parasite Peridinians; 3,000

francs to Dr. Fr. Croze, for the purchase of a concave diffraction grating and a 16 cm. objective, to be used in work on the Zeeman phenomena in line and band spectra; 6,000 francs to Dr. Hemsalech, for the purchase of a resonance transformer and battery of condensers, to be used in his spectroscopical researches; 2,000 francs to P. Laïs, for assisting the publication of the photographic star map; 2,000 francs to M. Pellegrin, to assist him in pursuing his researches and continuing his publications concerning African fishes; 2,000 francs to Dr. Trousset, to assist him in his studies of the minor planets; 2,000 francs to M. Vigouroux, to enable him to continue his researches on silicon and its different varieties; 3,000 francs to M. Ailuaud, to assist the publication (with Dr. R. Jeannel) of the scientific results of three expeditions to eastern and central Africa; 9,000 francs divided equally between MM. Pitart, de Gironcourt and Lecointre, members of the Morocco expedition, for scientific study, organized by the Société de Géographie; 2,000 francs to M. Vasseur, for the continuation of his geological excavations in a fossil-bearing stratum in Lot-et-Garonne; 3,500 francs to Dr. Mauguin, for the continuation of his work on liquid crystals and the remarkable phenomena presented by these bodies when placed in a magnetic field; 2,000 francs to Dr. Anthony, to defray the cost of his researches on the determinism of morphological characters and the action of primary factors during evolution; 4,000 francs to M. Andoyer, to assist the publication of his new set of trigonometrical tables; 4,000 francs to M. Bénard, to enable him to continue, on a larger scale, his researches on experimental hydrodynamics; 2,000 francs to Dr. Chauvenet, for the continuation of his researches on zirconium and the complex combinations of that element; 2,000 francs to François Franck, for the chronographic study of the development of the embryo, with special examination of the rhythmic function of the heart; 2,000 francs to M. Sauvageau, for the pursuit of his studies on the marine algæ. The committee recommends these eighteen grants after considering nearly sixty applications for assistance. The amount allocated for the year is 54,500 francs.

Wide variation in the pay for the same or similar work is one of the most striking situations revealed by the investigation of teachers' salaries just completed by the U. S. Bureau of Education, under the direction of J. C. Boykin, editor of the Bureau. Public elementary school-teachers may receive $2,400 a year, as some do in New York City, or $45 a year, as in certain rural communities. Even in cities of the same class there are considerable differences in the salaries paid teachers. On the administrative side there are county superintendents with pay ranging from $115 to $4,000 per annum, and college presidents receiving salaries from $900 to $12,400. In city school systems salaries have increased steadily in recent years, particularly in the western states; and, in general, salaries in city school systems are fairly well standardized. The average salary of the superintendent of schools in cities of over 250,000 population is $7,178; the range is from $4,000 to $10,000. In the same group of cities high-school principals average $3,565 and elementary teachers $1,018. Even in the smallest cities listed, those between 5,000 and 10,000 population, salaries are fairly uniform. The maximum for superintendents in this group is $3,600 and the average $1,915; but elementary teachers show an annual average of $533, with salaries as high as $1,350 and as low as $104. It is in the colleges and universities that the widest variation prevails. The salaries of men with the rank of "professor" range from $450 to $7,500. "Professors" in some institutions receive less than "instructors" or even "assistants" in others. Salaries of deans of these institutions vary from $500 to $5,000. University teachers of subjects for which there is direct commercial demand outside receive somewhat higher salaries than those in charge of the traditional academic subjects, but the difference is less than might be expected. The highest average salaries for full professors are paid in law and civil engineering. Law claims the highest paid professorship in any subject, with one salary of $7,500; but there are professors of

physics, geology and Latin who receive $7,000. It is significant, however, that on the basis of the figures reported most college teaching, particularly in the first two years, is done by men of instructor grade with salaries of $1,000 to $1,200, or by assistants who receive on the average about $500, usually for half-time services.

UNIVERSITY AND EDUCATIONAL NEWS

DR. H. T. SUMMERSGILL, superintendent of the New Haven Hospital, has been appointed superintendent of the University Hospital in San Francisco. Dr. Summersgill has arrived to take charge of the present hospital of the University of California Medical School, and to aid in completing the plans for the new teaching hospital buildings, to erect which $615,000 has been given by various friends of the university. Dr. Winford H. Smith, superintendent of the Johns Hopkins Hospital, recently spent a month in San Francisco, coming to California as expert adviser for the plans for the new hospital.

THE six-weeks' summer session of the University of California, for 1914, enrolled 3,101 students. It is expected that next year's summer session, coming while the Panama-Pacific Exposition will be in progress in San Francisco, will much exceed this year's enrollment. The freshman class at the University of California this year, excluding special students, will number over 1,700.

THE first summer school of the George Peabody College for Teachers has just come to a close. The total enrollment reached 1,006 regular students and 99 part-time visitors, coming from 28 states, including all of the southern states. This is possibly the largest enrollment with which any summer school has started. Next year the summer school will continue for twelve weeks instead of six, thus becoming a very integral part of the year's work which is to be divided into four quarters of twelve weeks each.

FRANCIS C. LINCOLN, associate professor in the mining department of the University of Illinois, has been made the head of the Mackay School of Mines of the University of Nevada.

MR. J. E. RUSH, of the University of Wisconsin, has been made assistant professor, in charge of the departments of biology and bacteriology, at the Carnegie Technical Schools, Pittsburgh.

THE governors of the Imperial College of Science and Technology, London, have appointed Dr. A. N. Whitehead, F.R.S., to the newly constituted chair of applied mathematics, and Dr. C. G. Cullis to the professorship of economic mineralogy.

DR. T. J. JEHU, lecturer on geology at the University of St. Andrews, has been appointed Murchison regius professor of geology and mineralogy in the University of Edinburgh, in succession to Professor James Geikie.

DISCUSSION AND CORRESPONDENCE

YOUNG WHITEFISH IN LAKE SUPERIOR

THE literature on the two species of whitefish that are so important commercially in our Great Lakes (*Coregonus albus* and *C. clupeaformis*), as well as unpublished statements received by the writer from prominent ichthyologists and fish culturists, makes it appear that little, if anything, is known concerning the very young of these fish as they exist in these bodies of water. Where the young whitefish, both native and those that are planted, live and what they feed upon in their natural habitats, constitutes an important problem for ichthyologists and fish culturists. Jordan and Evermann (1902),[1] writing of *Coregonus clupeaformis*, say:

> Nothing is definitely known regarding the general distribution and habits of the young, but they are supposed to remain chiefly in the deep waters of the lake.

During August, 1913, the writer studied the fish-life of the Whitefish Point Region in Northern Michigan, as one of the investigators sent there by the University of Michigan, with funds given for the work by the Hon.

[1] "American Food and Game Fishes," page 128; published by Doubleday Page and Company.

George Shiras. While making some collections from the shallow water of Lake Superior, not far from the Vermilion Life Saving Station near Whitefish Point, eighteen little whitefish were caught, which measured from 4.9 to 9 centimeters in length, from the tip of the snout to the tip of the caudal fin. They answer very well to the description of *Coregonus clupeaformis* (Mitchill), with certain departures undoubtedly due to their immature condition; but it is possible that some or all of them may be Lake Erie whitefish (*Coregonus albus* Le Sueur) for fry of this species have been planted in Lake Superior, according to information obtained from B. W. Evermann of the Bureau of Fisheries at Washington and H. H. Marks, superintendent of the Sault Ste. Marie Fish Hatchery. It has been impossible to distinguish the two species from a study of the structure of the small fish, for the adults are thought to differ from each other only in form and color, and no evidence can be obtained that the dark, lateral bands that are thought to be characteristic of the fry of *clupeaformis,* do not disappear shortly after that stage is passed.

The food of eight of the fish examined was found to be principally entomostracans, of which the following appear to be the chief species, according to the examinations of three typical stomach contents, made by Mr. Chancey Juday, of Madison, Wisconsin: *Bosmina longirostris* O. F. Müller, *Diaptomus ashlandi* Marsh, and *Cyclops viridus* Jurine (probably var. *parcus,* Herrick). Fragments of midge larvæ and miscellaneous insects, including winged forms, and filaments of a green alga (*Ulothrix zonata*), were the other objects noted among the food.

The eighteen specimens of young whitefish were taken in several hauls made with minnow seines, drawn over the sandy bottoms where the water was less than three feet deep and through the large schools of hundreds of small fish that were chiefly young lake herring (*Leucichthys* sp.). These were similar in size to the young whitefish associated with them, which were relatively very few in number, and superficially so like the little herrings that they could be picked from a collection only after a very careful examination of it.

Detailed descriptions of these young whitefish, their food, habitat and associates, will be given in the paper now being prepared on the fish-life of the Whitefish Point Region.

T. L. Hankinson

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IS THE POOR HATCHING OF NORMAL EGGS DUE TO THE PRESENCE OF MICROORGANISMS WITHIN THE EGGS?

The loss of young chicks due to the non-hatching of eggs is inestimable. Poultrymen have often said that "on an average a fifty per cent. hatch and a fifty per cent. raise was all that was generally obtained." What becomes of the other fifty per cent.? Wherein lies the cause of this heavy loss? Can it be due to the presence of microorganisms within the egg or rather to some inherent quality of the egg itself? We are aware of the fact that faulty incubation may be responsible in a large measure, but in this respect even the hen may have her troubles.

During the spring hatch we have had occasion to examine some 350 eggs, taken from both incubator and from under the hen. The eggs were those tested out as "non-fertile" or "dead in the shell." The incubation period ranged from ten days to twenty-two days. The eggs were from a flock of healthy birds and may be termed "normal" eggs.

In only one egg of the 350 eggs examined were bacteria found. The organism isolated belonged to the coli-typhi group.

From this, a preliminary report, we are of the opinion that the poor hatching quality of "normal" eggs is not directly due to the presence of microorganisms within the egg.

This work may serve to verify to a certain extent the findings of Rettger.[1]

T. D. Beckwith,
G. D. Horton

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[1] Bulletin No. 75, Storrs Agricultural Experiment Station.

HETERODERA RADICICOLA ATTACKING THE CANADA THISTLE

In addition to the large number of plants known to be attacked by *Heterodera radicicola*, the writer has recently had occasion to find it infesting a new host—the roots of the Canada thistle, *Cirsium arvense.*

On December 10, 1913, the writer noticed the first indications of the root knot, occurring on tomato plants. This crop was being grown in one of the greenhouses belonging to the Department of Horticulture. On April 28, 1914, the plants were removed on account of their unproductiveness. Many of the plants, at the time of removal, showed their entire root system infested and destroyed by this eel-worm.

On April 4, 1914, Mr. J. B. Poole, of the department of botany, called the writer's attention to nodules occurring on the roots of *Cirsium arvense.* These plants were growing in a separate greenhouse from the one in in which the tomato plants had been growing. The knots were very numerous, varying in diameter from two to ten mm. Their presence on the thistle roots, however, did not seem to interfere with the growth of this weed to any appreciable extent. A microscopic examination showed that the roots were badly infested with a nematode, and it seemed apparently to be the same species which occurred on the tomato. Cross sections of nodules showed the egg-filled bodies of female nematodes scattered throughout the cortex of the root. Specimens were sent to the Bureau of Plant Industry, and the determination verified.

The soil used in the various greenhouses was obtained from a nearby woodlot, and was probably badly infested with *Heterodera radicicola* at the time it was placed in the benches.

The fact that this organism is capable of living in the roots of *Cirsium arvense* should warrant the necessity of placing additional precautionary stress upon the eradication and destruction of this weed. Care should be exercised in treating soils before using, if the above weed should occur in any of the central or southern states, for the winters are probably not severe enough to kill the eel-worm by freezing.

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AN AVALANCHE OF ROCKS

The Cadillac Trail on Mount Desert is one of the most picturesque features of the island. It is near Otter Creek and one enters the trail from the shore road. The trail leads by a gentle ascent to an irregular line of massive rock fragments which have fallen from some preexisting precipice farther up the mountain side. The path runs through and under and over these titanic blocks, some of which must weigh hundreds if not thousands of tons. The blocks and fragments stand at all angles. I have had no opportunity to consult any book on the geology of the island, but a hasty examination of the region leads me to believe that this avalanche of rocks must have fallen from some precipice which had been undercut by the waves when the land was below sea level, as we know the whole New England coast has been elevated since the ice sheet retreated. The glacial clays with Arctic species of Mollusks, still living in Hudson Bay, are found from Danvers, Massachusetts, east to Lubec, Maine, and beyond, and indicate a former subsidence of the coast many feet below the level of the sea. Now if this event occurred at the time of this depression the material buried beneath these rocks would be of very great interest. If some large fragment rested on the parent ledge it could be tilted sufficiently by hydraulic jacks to enable one to gather the stuff beneath, and it might reveal the shells, diatoms, foraminifera, etc., living at the time of this catastrophe, and possibly the compressed vegetation might reveal important features also. The exploration could be made at a moderate expense and the conditions could be easily restored.

Edward S. Morse

SCIENTIFIC BOOKS

Problems of Genetics. By William Bateson. Yale University Press. 1913. Pp. ix + 255, illustrated.

The Silliman lectures delivered at Yale by Professor Bateson in 1907, revised and published in 1913 under the title "Problems of Genetics," form one of the most stimulating and suggestive books for students of Evolution and Heredity which has appeared since the rediscovery of Mendel's law. Like other books by the same author, it is not designed for beginners but for actual workers in the field covered, and is no fit food for babes and sucklings. To the student familiar with current theories and lines of investigation concerning evolution the frank criticism of those theories and investigations will be especially valuable. Present knowledge is recognized to be imperfect and tentative, and while the author expresses an emphatic preference for certain views, he holds them without dogmatism or claim to finality, an attitude in scientific work which, with every advance, we need to remind ourselves of anew.

In his introduction, Bateson addresses himself to the old but unsolved question of the nature and origin of species, which he blames the discussion over natural selection for obscuring. He says: "In the enthusiasm with which evolutionary ideas were received the specificity of living things was almost forgotten. The exactitude with which the members of a species so often conform in the diagnostic, specific features passed out of account; and the scientific world by dwelling with a constant emphasis on the fact of variability, persuaded itself readily that species had after all been a mere figment of the human mind. Without presuming to declare what future research only can reveal, I anticipate that, when variation has been properly examined and the several kinds of variability have been successfully distinguished according to their respective natures, the result will render the natural definiteness of species increasingly apparent." Bateson rejects natural selection as a sufficient explanation of the origin of species, concluding that we are on safer ground "in regarding the fixity of our species as a property inherent in its own nature and constitution." He says: "As soon as it is realized how largely the phenomena of variation and stability must be an index of the internal constitution of organisms, and not mere consequences of their relations to the outer world, such phenomena acquire a new and more profound significance." In Chapters II.–IV., Bateson attempts a classification of variations along lines indicated in his "Materials" (1896). This may have been important historically in leading Bateson to his later views concerning the discontinuity of evolution, but to most readers will seem aside from the main discussion. Taking up in Chapter V. the mutation theory, he expresses the view that a new species originates in a changed "internal constitution of the organism," which with DeVries he believes to arise discontinuously. But the discontinuity, according to Bateson, is of Mendelian unit-characters or factors only. He explicitly rejects the DeVriesian idea of mutation involving a change in a whole group of characters simultaneously, and explains the peculiar genetic behavior of *Œnothera Lamarckiana* as due to hybridization.

"The facts may, I think, fairly be summarized in the statement that species are, on the whole, distinct and not intergrading, and that the distinctions between them are usually such as might be caused by the presence, absence or inter-combination of groups of Mendelian factors; but that they are so caused the evidence is not yet sufficient to prove in more than a very few instances.

"The alternative, be it explicitly stated, is not to return to the view formerly so widely held, that the distinctions between species have arisen by the accumulation of minute or insensible differences. The further we proceed with our analyses the more inadequate and untenable does that conception of evolutionary change become. If the differences between species have not come about by the addition or loss of factors one at a time, then we must suppose that the changes have been effected by even larger steps, and variations, including groups of characters, must be invoked.

"That changes of this latter order are really those by which species arise is the view

with which DeVries has now made us familiar by his writings on the mutation theory. In so far as mutations may consist in meristic changes of many kinds and in the loss of factors, it is unnecessary to repeat that we have abundant evidence of their frequent occurrence. That they may also more rarely occur by the addition of a factor we are, I think, compelled to believe, though as yet the evidence is almost entirely circumstantial rather than direct. The evidence for the occurrence of those mutations of higher order, by which new species characterized by several distinct features are created, is far less strong, and, after the best study of the records which I have been able to make, I find myself unconvinced. The facts alleged appear capable of other interpretations.

"DeVries found, as is well known, that *Œnothera Lamarckiana* gives off plants unlike itself. These mutational forms are of several distinct and recognizable types which recur, and several of them breed true from their first appearance. The obvious difficulty, which in my judgment should make us unwilling at present to accept these occurrences as proof of the genesis of new species by mutation, is that we have as yet no certainty that the appearance of the new forms is not an effect of the recombination of factors, such as is to be seen in so many generations of plants derived from a cross involving many genetic elements."

The phenomenon of twin-hybrids he does not consider satisfactory evidence of *group inheritance* of characters, but to have its best explanation "in the well ascertained fact that the male and female germ-cells of the same individual may be quite different." By this is meant that the pollen and ovules of the same plant may transmit different qualities respectively.

In order to throw light on the question whether species originate discontinuously or not, Bateson discusses, in successive chapters, "Variation and Locality," "Overlapping Forms," and "Climatic Varieties," bringing together a great amount of illustrative material partly of his own collecting, partly the work of others. Special attention is given to the nearly related species of North American flickers and of warblers, which are illustrated by two beautiful colored plates. These cases have been selected because they seem to show specific differences consisting in Mendelizing unit characters. Even in these cases, however, the existence of such unit characters is inferential rather than demonstrated and actual experimental work on the crossing of wild species of birds, such as pheasants studied by Ghigi and Phillips, and pigeons studied by Whitman, though it reveals the frequent occurrence of unit character differences between one domesticated variety and an original wild species, rarely shows the existence of such differences between one wild species and another. Even granting that unit character differences occasionally occur between one wild species and another (as I believe they do), it may well be that such differences, though striking, are not the most important or essential ones. As Bateson himself says in another connection (p. 184), "It seems in the highest degree unlikely that the outward and perceptible character or characters which we recognize as differentiating the race should be the actual features which contribute effectively to that result." If an extensive survey were made of related wild species of birds or mammals, I suspect that it would be found that the discoverable differences in a majority of cases consist in quantitative differences in characters, rather than in presence and absences of striking single characters. Consider for example the genus *Mus*. The black rat, *M. rattus*, as the experiments of Morgan and Bonhote have shown, is distinguished from *M. alexandrinus* by a single unit character difference. The two cross freely and Mendelize on crossing, but without producing any new third form, so far as we know at present. The color difference between them is a very striking one, but it appears to be the only existing difference. The one might be described as a color variety of the other.

Compare now *M. alexandrinus* with *M. norvegicus*. The two are very similar in appearance. Only quantitative differences in

size and proportions of parts serve to distinguish them. Yet they are so distinct genetically that they never cross naturally and all attempts to cross them artificially have thus far failed. No one would, I think, advocate the idea that one had arisen from the other by unit character variations, such as distinguish *M. rattus* from *M. alexandrinus* or striking tame varieties of the Norway rat from the wild species. The differences in these latter cases are unquestionable, and their genetic behavior clear, but if we call forms so distinguished *species* it is evident that we are applying the term on the basis of very different phenomena from those which serve to distinguish *M. alexandrinus* from *M. norvegicus* or *M. musculus*. In these cases the observable differences are quantitative and their genetic behavior unknown. There is small reason for considering them unit character differences. It is of course possible so to regard them if one conceives of unit characters or factors in such cases as very numerous and singly with small effect, in accordance with the principle of Nilsson-Ehle. But so to conceive of a unit character is to rob it entirely of that which the theory of discontinuity in the evolution of species requires and which Bateson seeks to establish. Multiple unit characters presenting an apparently continuous series would also have no selectional value superior to that of a *truly* continuous series of variations, the conception which Bateson combats.

Bateson devotes one of the most valuable chapters of his book to the subject of adaptation, without either reaching or attempting to reach any explanation of it. Indeed he rather deplores the fact that so much attention has been devoted to the adaptation of species before we have arrived at any clear notion as to what species are or how they arise. The chief value of Bateson's discussion of this question lies in the destructive criticism which he offers of the attempted explanation of adaptation as a direct response of the organism perpetuated by heredity. He passes over the earlier discussions concerning the inheritance of acquired characters, but deals with its recent vigorous renewal by Semon, who regards heredity as analogous with memory or habit. Bateson holds that an analogy with psychic phenomena is no explanation, among other reasons because the explanation is necessarily more complicated than the thing explained. The evidence on which Semon relies to establish the inheritance of acquired characters, Bateson deals with at some length. He shows the inadequacy of the oft-cited temperature experiments with lepidoptera to show either an increased variability due to experiment or its inheritance. The case of Schubeler's wheat adapting itself automatically to the shorter season of Norway is subjected to destructive criticism, as is also the case of Brown-Sequard's guinea-pigs, so often brought forward, so often shown to be of no consequence. Special attention is given to the recent work of Kammerer at Vienna upon salamanders, on which Semon places great reliance. By keeping land salamanders in water and vice versa, Kammerer claims to have modified the structure and habits of these animals permanently, the young inheriting the acquired modifications of the parents even when restored to normal conditions, and the inherited effect increasing from generation to generation upon continuation of the experimental conditions. Bateson shows that these extensive claims are based on wholly inadequate experiments, that the author is unable or unwilling to produce specimens of the modified structures which he claims to have obtained, and that unless his observations are independently confirmed it is "easier to believe that mistakes of observation or of interpretation have been made than that any genuine transmission of acquired characters has been witnessed."

"Meanwhile there is no denying that the origin of adaptational features is a very grave difficulty. With the lapse of time since evolutionary conceptions have become a universal subject of study that difficulty has, so far as I see, been in no wise diminished. But I find nothing in the evidence recently put forward which justifies departure from the agnostic position which most of us have felt obliged to assume."

A chapter of especial interest to Americans discusses "The Causes of Genetic Variation," for the work reviewed is to a considerable extent that of American biologists, who have attempted to produce and claim to have succeeded in producing heritable variations under controlled experimental conditions. The work of Woltereck in Germany has shown, according to Bateson, that the character of the food supplied to a parthenogenetic *Daphnia* affects the structure of her immediate offspring, but the effect does not persist further into subsequent generations. Hence there is no permanent racial influence. Tower, however, in potato-beetles, and MacDougal in *Raimannia* claim to have brought about permanent racial changes, the one by altering the temperature and humidity at which the parent beetles are kept, the other by injecting certain salt solutions into the ovaries of the parent plants. Bateson points out that neither of these important results has been independently confirmed by experiment, though this has been attempted by Compton with negative results in the case of *Raimannia*. After reviewing Tower's two principal papers and pointing out a number of inconsistencies, Bateson adds

"The hesitation which I had come to feel respecting these two publications of Tower's has been, I confess, increased by the appearance of a destructive criticism by Gortner who has examined the parts of Chapter III of Tower's book in which he discusses at some length the chemistry of the pigments in *Leptinotarsa* and other animals. As Gortner has shown, this discussion, though offered with every show of confidence, exhibits such elementary ignorance, both of the special subject and of chemistry in general, that it can not be taken into serious consideration."

Regarding MacDougal's work he says, emphasizing the need of repeating the experiment with *Raimannia:*

"He [MacDougal] adds that he is making similar experiments with some twenty genera; but what is more urgently needed is repeated confirmation of the original observation. When it has been shown that this mutation can be produced with any regularity from a plant which does not otherwise produce it on normal self-fertilization, the enquiry may be profitably extended to other plants."

The net result of Bateson's discussion of the causes of genetic variation is negative. No means of controlling genetic variation has, he believes, yet been found.

A chapter dealing with The Sterility of Hybrids presents many interesting questions without answering any of them satisfactorily. Interspecific sterility is shown to be important in keeping species distinct, and it is suggested that in some cases at least it is connected with unit character inheritance, but beyond this point all is uncertainty.

In his concluding remarks, Bateson emphasizes the present partial and incomplete state of our knowledge of genetic problems and in particular of what a species really is. He expresses the conviction that it is not a mere arbitrary group of organisms, though to the systematists it can hardly be anything else. "Their business," says Bateson, "is purely that of the cataloguer, and beyond that they can not go. They will serve science best by giving names freely and by describing everything to which their successors may possibly want to refer, and generally by subdividing their material into as many species as they can induce any responsible society or journal to publish.

"As yet the genetic behavior of animals and plants has only been sampled. When the work has been done on a scale so large as to provide generalizations, we may be in a position to declare whether specific difference is or is not a physiological reality."

W. E. Castle

Vorträge über Deszendenztheorie. Von August Weismann. Dritte umgearbeitete Auflage. Jena, G. Fischer. 1913. Pp. xiv + 354, 3 pls., 137 figs. in text.

Mendel's Principles of Heredity. By W. Bateson. Cambridge, Eng., Univ. Press, and New York, G. P. Putnam's Sons. 1913. 3d Impression. Pp. xiv + 413, illustr.

These two books deal with the two most im-

portant advances which have been made in the study of evolution since the time of Darwin, namely the theories of Weismann and Mendel.

For whether one accepts or rejects these theories, no one will question their great value in stimulating research concerning evolutionary problems, the productiveness of which has been enormous in the last thirty years.

It was in the early eighties that Weismann in his essays on heredity challenged the general belief in the inheritance of acquired characters and pointed out the logical distinction between soma and germ-plasm, which despite numberless attacks still stands. Ten years later "The Germ-plasm" theory was published in its fully developed form, and after another decade of debate and study "The Evolution Theory" was published, in which Weismann attempted to make a comprehensive survey of the entire field of evolution as seen in the light of his germ-plasm theory. In the first sentence of his preface, as translated by Thomson, he says: "When a life of pleasant labor is drawing to a close, the wish naturally asserts itself to gather together the main results, and to combine them in a well-defined and harmonious picture which may be left as a legacy to succeeding generations." Succeeding generations have reason to be grateful to Weismann that he undertook thus to present his mature views. Few books on evolution since the publication of Darwin's "Origin of Species" can be read with greater pleasure or profit than this, or are likely longer to survive. To English readers it is accessible in a faithful translation made by Professor and Mrs. J. A. Thomson in their usual clear and graceful style.

The popularity of the original is shown by the fact that a second edition was called for within two years, the third and doubtless final edition being the one before us. In the second edition few changes were made, beyond the addition of a few notes, but by the time the third edition was issued (1913) Mendelism had so far developed as to call for extended review. Weismann welcomes Mendelism as a confirmation of the basic idea of his germ-plasm theory, the doctrine of determiners. Mutation he rejects as inconsistent with the view that adaptations arise gradually through the action of natural selection.

Bateson's book, first published in 1909, may be regarded as the authoritative interpretation of Mendelism. It contains a biography and three portraits of Mendel with a translation of his original papers, and also a comprehensive account of Mendelian principles as developed by the Bateson-Punnett group of workers at Cambridge University. The first edition of the book was exhausted within a few months of its publication and it was then reprinted without change. The present "third impression" was taken advantage of to add "a series of brief appendices to acquaint the reader with the nature of the principal advances made, while awaiting an opportunity of rewriting the book." The "appendices" mentioned consist of brief notices of subsequent publications, which, however, fail to give an adequate notion of their content, or of the direction which the further development of Mendelism has taken since 1909. The book is rightly and honestly called a "third impression," not a new edition. It is essentially a portrait of the Mendelism of 1909, and seeks to combine the fundamental idea in the germ-plasm theory (that of determiners) with the fundamental idea in mutation (that of the sudden origin of characters).

W. E. Castle

SPECIAL ARTICLES

A NEW METHOD FOR THE DETERMINATION OF SOIL ACIDITY [1]

Soil acidity problems are at the present time, perhaps, the most important of all soil problems confronting the farmers of Wisconsin and many other states. In studying these problems one of the most serious drawbacks has been the lack of suitable qualitative and quantitative methods for the determination of this acidity. The litmus-paper test when properly made is a fairly satisfactory qualitative test and has been our most reliable test.

[1] Publication authorized by the Director of the Wis. Expt. Station.

However, carbonic acid reacts acid to litmus, and, contrary to general belief, the reddening of litmus paper when put into carbonated water for several minutes is permanent even on drying. In testing fresh soil it is therefore necessary to keep all living plant roots away from the paper, as they may turn it red, due to the excretion of carbon dioxide. The soil water may be highly enough charged with carbon dioxide to affect the test. The moist hand must also not come in contact with the litmus paper, for that may redden the paper. When a soil is only slightly acid the litmus test is not sharp and positive and thus often causes confusion.

With a view of securing a more reliable test the writer has evolved the following zinc sulfide method. It was found that acid soils when boiled with zinc sulfide and water would liberate hydrogen sulfide, which, as is well known, can be detected very easily and positively with lead acetate paper. With this as a basis, the following method was worked out:

Ten grams of soil are placed in a 300 c.c. Erlenmeyer flask and to this is added 1 gr. calcium chloride, 0.1 gr. of zinc sulfide, and 100 c.c. water. This is thoroughly shaken and then heated over a flame. After the contents have boiled one minute, a strip of moistened lead acetate paper is placed over the mouth of the flask and the boiling continued two minutes more, when the paper is removed. If the soil is acid the paper will be darkened on the under side in proportion to the degree of acidity. If it is non-acid, no darkening will occur *if the test has been performed as just outlined.*

The calcium chloride is added to make the test more sensitive. It reacts with the comparatively insoluble soil acids and forms a small amount of hydrochloric acid which readily liberates hydrogen sulfide from zinc sulfide. The mixture is boiled one minute before putting the test paper in place in order to expel most of the carbon dioxide and also to more nearly bring all tests to the same condition before applying the paper. This test will positively detect smaller amounts of soil acids than the litmus test. The range of colors, showing degree of acidity, is large, being from white to black.

At first thought it seems possible that on boiling soils with water, some which had undergone anaerobic fermentation might give off appreciable amounts of hydrogen sulfide and thus confuse the test. On careful consideration this appears very improbable, for if the soil is alkaline any hydrogen sulfide formed in the process of fermentation will combine with the excess of bases present and is thus not given off in the test. Fresh peat and muck soils, some of which had lately been inundated, were tested and in no cases did the alkaline ones give a coloration to the test paper. The test has been applied to a considerable number of soils and also other materials of known reaction and as yet not a single objection to the test has arisen.

As a quantitative method, an effort is being made to measure the degree of acidity by titrating with standard iodine solution the hydrogen sulfide which a soil will liberate. Whether this will work with all soils has as yet not been determined. By using this test for the end point in the Veitch lime water method for acidity or lime requirements, the present Veitch method is considerably shortened and made far more accurate.

The most important part of the test, however, is the fact that it can be made approximately quantitative, and still require only very simple apparatus—such as can be carried right into the field, and require no more than ten to fifteen minutes for the determination. This will make it of great value to the extension man, field agent, etc. In fact, the farmer himself will be able to determine the lime requirements of his soil, by following very simple directions. The principle of this quantitative method depends upon the fact that for any particular class of soils the degree of acidity is closely proportional to the intensity of color produced on the paper when the test is conducted as previously outlined. The color on the test paper needs only to be compared to a standard color scale and from an accompanying table the degree of acidity or lime requirements is read off directly. This standard color

scale is now being prepared and checked up with standard soil acids made by new methods.

E. TRUOG

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EXPERIMENTAL EFFORTS TO RETAIN THE FRESHNESS IN CUT ROSE BLOOMS[1]

DURING the spring of 1908 the Rhode Island Station had a large surplus of rose blooms from its experimental beds, and at the suggestion of Dr. H. J. Wheeler, who was then director of the station, the writer carried on over one hundred and fifty tests with solutions of various kinds of chemicals and in various concentrations, to ascertain their effect in promoting the keeping qualities of the cut blooms, whereby the average housewife could with slight trouble and expense prolong materially the period of freshness of the blooms; thus increasing largely the usefulness of the rose as a home decoration.

Most of the tests were made in May, 1908, while the final tests were completed in July, 1913.

The varieties of rose blooms used in 1908 were Brides and Bridesmaids, while the Maryland was used in 1913.

In most cases the blooms were taken immediately after being cut, and divided into uniform groups of six to eight. The stems were cut from 7 to 10 inches long, and placed in wide-mouthed flasks of 500 c.c. capacity. Ordinary water was used as the solvent in all of the tests, and a control flask was included with each lot of blooms, all of which were kept under laboratory conditions and in the original solutions for periods of from four to seven days. The number of tests of a given concentration of a chemical varied from one with the extremes to as high as three or four with some of the medium dilutions.

In the following table the degrees of concentration of the solutions are divided into the lowest used, the highest used which was not injurious, and those used which proved injurious.

PARTS IN 10,000

	Smallest Number of Parts Used	Largest Number of Parts Not Injurious	No. of Parts Used that Proved Injurious
Alcohol	—	—	50–200
Ammonium hydroxid	50	100	700–1,000
Borax	1	5	20–250
Boric acid	2	5	10
Carbolic acid	—	—	2–100
Ether	—	30	50–500
Formalin	—	—	10–200
Glycerine	—	—	50–100
Iron, solid, powdered	—	10	—
Magnesium sulfate	—	1	100
Nutrient solution[2]	5	10	—
Potassium nitrate	1	10	25
Potassium permanganate	0.2	2.5	10
Sodium carbonate	—	5	20
Sodium chlorid	1	10	100–250
Sodium nitrate	1	10	—
Sodium sulfate	—	—	2–5
Sodium sulfite	2	5	10–50
Sugar	10	1,000	—
Sulfuric acid	—	30	50–150

A mixture of one part of carbolic acid and three parts ammonium hydroxid in 10,000 did not prove injurious, while two parts carbolic acid and 50 parts ammonium hydroxid did prove injurious.

Of all the tests, a strong sugar solution, 7–10 per cent., was the only one that caused any marked freshening in the appearance of the blooms. This effect was shown by a deepening of the color of the pink varieties within a few hours after the stems were placed in the sugar solution, whereas those in water faded much sooner. However, the breaking down of the blooms and the dropping of their petals occurred at the same time in the flasks containing sugar as in those containing only water.

When clean flasks were used, the changing of the water daily, or the cutting off of the end of the stems and changing the water daily did not prolong the keeping qualities of the blooms.

F. R. PEMBER

RHODE ISLAND EXPERIMENT STATION

[1] Contribution 205 from the Agricultural Experiment Station of the Rhode Island State College, Kingston.

[2] Contained 20 c.c. .1 N $Ca(NO_3)_2$, 10 c.c. .1 N NH_4NO_3, 8 c.c. .1 N KCl, 8 c.c. .1 N $CaH_4(PO_4)_2$, 16 c.c. .1 N $MgSO_4$ and 10 c.c. .001 N $Fe_2(NO_3)_6$ per L.

SCIENCE

FRIDAY, SEPTEMBER 11, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS TO THE BOTANICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

To preside over the Botanical Section on the occasion of its first meeting in Australia is no slight honor, though it also imposes no small responsibility. We members from Great Britain have a deep sense of the advantage which we derive from visiting these distant shores. I am doubtful whether any scientific profit we can confer by our coming here can balance that which we receive; while over and above this is the personal kindliness of the Australian welcome, which on behalf of the visitors of this section from the old country I take this opportunity of gratefully acknowledging. Of the members of the British Association, those who pursue the national sciences may expect to gain most by their experiences here; and perhaps it is the botanists who stand to come off best of all. Living as most of us do in a country of old cultivation, the vegetation of which has been controlled, transformed, and from the natural floristic point of view almost ruined by the hand of man, it is with delight and expectation that we visit a land not yet spoiled. To those who study ecology, that branch of the science which regards vegetation collectively as the natural resultant of its external circumstances, the antithesis will come home with special strength, and the opportunity now before them of seeing nature in her pristine state will not, I am sure, be thrown away.

I may be allowed here to express to the Australian members of the Section my regret that the presidency for this occasion

[1] Australia, 1914.

should not have fallen to one who could with unusual weight and knowledge have addressed them from the floristic and geographical point of view. I mean, to Professor Bayley Balfour, of Edinburgh, who was actually invited by the council to preside. He could have handled the subject of your rich and peculiar flora with detailed knowledge; and, with the true Hookerian touch, he would have pictured to you in bold outlines its relation to present problems. Failing such equipment, I may at least claim to have made some of your rare and peculiar forms the subject of special study at intervals spread over thirty years: for it was in 1884 that I was supplied with living plants of *Phylloglossum* by Baron Ferdinand von Müller, while a paper to be published this year contains details of a number of ferns kindly sent to me by various collectors from New Zealand. I have been personally interested more especially in your rare Pteridophytes, isolated survivals as they surely are of very ancient vegetation. I propose to indicate later in this address some points of interest which they present. But first I shall offer some more general remarks on the history of the investigation of the Australian flora, as a reminder of the recent death of Sir Joseph Hooker, whose work helped so greatly to promote a philosophical knowledge of the flora of this quarter of the globe.

Few, if any, of the large areas of the earth's surface have developed their coat of vegetation under such interesting conditions as that which bears the Australasian flora. In its comparative isolation, and in its freedom from the disturbing influence of man, it may be held as unique. We may picture to ourselves the field as having been open to evolutionary tendencies, unusually free from the incursion of competitive foreign types, and with its flora shaped and determined through long ages in the main by climatic influences. Naturally the controlling effect of animal life had been present throughout, as well as that of parasitic and fungal attack; but that potent artificial influence, the hand of man, was less effective here than in almost any other area. The aborigines were not tillers of the soil: in their digging for roots and such-like actions they might rank with the herbivorous animals, so far as they affected the vegetation. Probably the most powerful influence they exercised was through fire. And so the conditions remained, the native flora being practically untouched, till the visit of Captain Cook in 1770: for little account need be taken of the handful of specimens collected by Dampier in the seventeenth century.

Captain Cook shipped with him in the *Endeavour* a very remarkable man, viz., Joseph Banks, whom Dr. Maiden has described as "the Father of Australia." He not only acted as the scientific director of the expedition, but he was also its financier. Educated at Eton and Oxford, he found himself as a young man possessed of an ample fortune. Though devoted to field sports, he did not, like so many others, spend his life upon them. Following the dictates of a taste early awakened in him, he turned his attention to travel for scientific ends. His opportunity came when Cook was fitting out the *Endeavour* for his first voyage to the southern seas. Banks asked leave of the Admiralty to join the expedition, which was granted, and he furnished all the scientific stores and a staff of nine persons at his own expense.

The story of that great expedition of 1768 to 1771 is given in "Cook's Voyages," compiled by Dr. Hawkesworth, a book that may be found in every library. Though it is evident throughout that Banks took a leading part in the observational

work of the expedition, it has not been generally known how deeply indebted Hawkesworth was to Banks for the scientific content of his story. This became apparent only on the publication of Banks's own journal 125 years after the completion of the voyage. The circumstances of this have a local interest, so I may be excused for briefly relating them.

Banks's papers, including the MS. journal, passed with his library and herbarium on his death to his librarian, Robert Brown. On the death of the latter they remained in the British Museum. But after lying there for a long period they were claimed and removed by a member of Banks's family, and were put up for auction. The journal was sold for £7 2s. 6d., and the last that has been heard of it is that it came into the possession of a gentleman in Sydney. Perhaps it may be lying within a short distance of the spot where we are now met. This valuable record, fit to rank with Darwin's "Voyage of the *Beagle*," or Moseley's account of the "Voyage of the *Challenger*," might thus have been wholly lost to the public had it not been for the care of Dawson-Turner, who had the original transcribed by his daughters, helped by his grandson, Joseph Dalton Hooker. The boy was fascinated by it, and doubtless it helped to stimulate to like enterprises that botanist to whom Australia owes so much. The copy thus made remained in the British Museum. Finally, from it in 1896 Sir Joseph Hooker himself edited the journal, in a slightly abridged form. It is now apparent how very large a share Banks actually took in the observation and recording, and how deeply indebted to him was the compiler of the account of the voyage published more than a century earlier, not only for facts, but even for lengthy excerpts.

The plants collected in Australia by this expedition amounted to some 1,000 species, and with Banks's herbarium they found, after his death, a home in the British Museum. Several minor collections were subsequently made in Australia, but the next expedition of prime importance was that of Flinders in 1801 to 1805. What made it botanically notable was the presence of Robert Brown. Hooker speaks of this voyage as being, "as far as botany is concerned, the most important in its results ever taken." The collections came from areas so widely apart as King George's Sound, southern Tasmania, and the Gulf of Carpentaria. These, together with Banks's plants and other minor collections, formed the foundation for Brown's "Prodromus Floræ Novæ Hollandæ," a work which was described in 1860 by Sir Joseph Hooker as being "though a fragment . . . the greatest botanical work that has ever appeared." It was published in 1810. I must pass over without detailed remark the notable pioneer work of Allan Cunningham, and of some others. The next outstanding fact in the history of Australian botany was the voyage of Ross, with the *Erebus* and the *Terror*: for with him was Joseph Hooker, whose botanical work gave an added distinction to an otherwise remarkable expedition.

The prime object of the voyage was a magnetic survey, and this determined its course. But in the intervals of sailing the Antarctic seas the two ships visited Ascension Island, St. Helena, the Cape, New Zealand, Australia, Tasmania, Kerguelen Island, Tierra del Fuego, and the Falkland Islands. Thus Hooker had the opportunity of collecting and observing upon all the great circumpolar areas of the southern hemisphere. He welded together the results into his great work "The Antarctic Flora." It was published in six large quarto volumes. In them about 3,000

species are described, while on 530 plates 1,095 species are depicted, usually with detailed analytical drawings. But these magnificent volumes did not merely contain reports of explorations, or descriptions of the many new species collected. There was much more than this in them. All the known facts that could be gathered were incorporated, so that they became systematically elaborated and complete floras of the several countries. Moreover, in the last of them, the "Flora Tasmaniæ," there is an introductory essay, in which the Australasian flora was for the first time treated as a whole, and its probable origin and its relation to other floras discussed. Further, questions of the mutability and origin of species were also raised in it. The air was full of such questions in 1859; the essay was completed in November of that year, less than twelve months after the joint communications of Darwin and Wallace had been made to the Linnean Society, and before the "Origin of Species" was published. It was to this essay that Darwin referred when he wrote that "Hooker has come round, and will publish his belief soon." But this publication of his belief in the mutability of species was not merely an echo of assent to Darwin's own opinion. It was a reasoned statement, advanced upon the basis of his "own self-thought," and his own wide systematic and geographical experience. From these sources he drew support for "the hypothesis that species are derivative and mutable." He points out how the natural history of Australia seemed especially suited to test such a theory, on account of the comparative uniformity of the physical features being accompanied by a great variety in its flora, and the peculiarity of both its fauna and flora, as compared with other countries. After the test had been made on the basis of the study of some 8,000 species of plants, their characters, their spread, and their relations to those of other lands, Hooker concluded decisively in favor of mutability, and a doctrine of progression. After reading this essay, Darwin wrote that it was to his judgment "by far the grandest and most interesting essay on subjects of the nature discussed I have ever read."

But beyond its historical interest in relation to the "Origin of Species," Hooker's essay contained what was up to its time the most scientific treatment of a large area from the point of view of the plant-geographer. He found that the Antarctic, like the Arctic flora, is very uniform round the globe. The same species in many cases occur on every island, though thousands of miles of ocean may intervene. Many of these species reappear in the mountains of southern Chili, Australia, Tasmania, and New Zealand. The southern temperate floras, on the other hand, of South America, South Africa, Australia, and New Zealand differ more among themselves than do the floras of Europe, northern Asia, and North America. To explain these facts Hooker suggested the probable former existence, during a warmer period than the present, of a center of creation of new species in the Southern Ocean, in the form of either a continent or an archipelago, from which the Antarctic flora radiated. From the zoological side a similar difficulty arises, and the hypothesis of a land-connection has been widely upheld, and that it existed as late as Mid-Tertiary times. The theory took a more definite form in the hands of Osborn (1900), who pictured relatively narrow strips of land connecting respectively South America on the one side and Tasmania and New Zealand on the other with the existing Antarctic land-area. This would accord well enough with the suggestion of Lothian Green, that the

plan of land-elevations on the earth is approximately tetrahedral; and it is, I believe, in line with the views of those who are best informed on antarctic geography and geology, as studied from the land itself. It may be hoped that further antarctic discovery may bring fresh facts to bear upon this question, for it is to the positive data acquired from study of the earth's crust that we must look, rather than to the exigencies of botanists and zoologists, for its final solution.

But the hypothesis of an Antarctic land-connection has been held open to doubt in various quarters. As Sir Wm. Thiselton Dyer has recently pointed out, Darwin himself dissented, though regretfully, from the sinking of imaginary continents in a quite reckless manner, and from the construction of land-bridges in every convenient direction. From the geological side Dana laid down the positive proposition that the continents and oceans had their general outline and form defined in earliest time. Sir John Murray, whose recent death we so deeply deplore, was an undeniable authority as to the ocean-floor. He wrote quite recently with regard to Gondwana-land, that "the study of ocean-depths and ocean-deposits does not seem in any way to support the view that continental land has disappeared beneath the floor of the ocean in the manner indicated." He suggested that the present distribution of organisms is better interpreted by the North Polar theory of origin. The "continuous current of vegetation" southward at the present time was recognized by Hooker himself, and definite streams of northern forms have been traced by him extending even to Australia and Tasmania. This might account for much in present-day distribution; though it seems doubtful whether it would fully explain the extraordinary distribution of Antarctic plants. The problem must for the present remain an open one.

This whole question, however, has a connection with the still wider difficulty of the existence within the polar area of ancient floras. In the north the fossils are even of sub-tropical character. Coal has been found in lands with a five months' night. How did such plants fare if the seasonal conditions were at all like the present? To explain this it would be a physiological necessity to assume either an entirely different climatal condition in those regions from that of the present time; or, as has been suggested, some shifting or creeping of the earth's crust itself. These are, however, questions which we can not undertake to discuss with effect in the Botanical Section. We must not do more than recognize that an unsolved difficulty exists.

We pass now from Hooker's great work to the last of the classical series, viz., the "Flora Australiensis" of Bentham and Baron Ferdinand von Müller. It is embodied in seven volumes, and was completed in 1878. Bentham, while assenting in his "concluding preface" to the principles laid down by Hooker in the Tasmanian flora, recognized as the chief component part of the present flora of Australia the indigenous genera and species, originated or differentiated in Australia, which never spread far out of it. Secondly, an Indo-Australian flora showing an ancient connection between Australia and the lands lying to the north. It is represented especially in tropical and sub-tropical east Queensland. Then there is the mountain flora common to New Zealand, and extending generally to the southern extra-tropical and mountain regions, while other constituents are ubiquitous maritime plants, and those which have been introduced since the European colonization. But the most remarkable, as they are

the least easily explained, are some few plants identical with species from North and West America, and from the Mediterranean. They are stated to be chiefly annuals, or herbaceous or shrubby plants; free-seeders; while their seeds long retain the power of germination. This may perhaps give the clue to this curious conundrum of distribution.

It has been fortunate that the duty of working out this remarkable flora should have fallen into the hands of such masters as Robert Brown, Sir Joseph Hooker, and Bentham. The foundations were thus surely laid. The further progress of knowledge has been carried on by the late Baron Ferdinand von Müller, and it may be confidently left in the hands of others who are still with us. The completion of the task of observing and recording may still be far ahead. But I may be pardoned if I utter a word of anticipatory warning. There is at the present time a risk that the mere work of tabulating and defining the species in a given country may be regarded as the only duty of a government botanist; that, whenever this is completed, his occupation will be gone. Some such erroneous idea, together with a short-sighted economy, is the probable explanation of the fact that certain positions hitherto held by professional botanists have recently been converted into positions to be held by agriculturists. In the countries where this has happened (and I refer to no part of Australasia) the vegetation had been very adequately, though not yet exhaustively, worked, as regards the flowering plants and ferns. But who that knows anything about plants would imagine that the ascription to a genus or order, or the designation by a couple of Latin names with a brief specific description, exhausts what it is important to know about a species? In most cases it is after this has been done that the real importance of its study begins. Such possibilities as these do not appear to have been appreciated by those who advised or controlled these official changes. I have no desire to undervalue the agriculturist or the important work which he does. But he is engaged in the special application of various pure sciences, rather than in pure science itself. Advance in the prosperity of any country which has progressed beyond the initial stages of settlement follows on the advance of such knowledge as the devotee of pure science not only creates, but is also able to inculcate in his pupils. It is then imperative that, in any state which actively progresses, provision shall be made for the pursuit of pure as well as of applied science. In my view an essential mistake has been made in changing the character of the appointments in question from that of botanists to that of agriculturists. For the change marks the abandonment of pure science in favor of its specialized and local application.

The head of such an institution should always be a representative of pure science, thoroughly versed in the nascent developments of his subject. He could then delegate to specialists the work of following out into detail such various lines of special application as agriculture, acclimatization, plant-breeding, forestry or economics. Or, if the organization were a large one, as we may anticipate that it would become in the capital of a great state, separate institutes might develop to serve the several applied branches, while to a central institute, in touch with them all, might be reserved the duty of advancing the pure science from which all should draw assistance and inspiration.

It matters little how this principle works out in detail, if only the principle itself be accepted, viz., that pure science is the fount

from which the practical applications spring. Sydney, as the capital of a great state, has already laid her course, as regards botanical science, in accordance with it. Her botanic garden and the recently developed botanical department in the university (which, I understand, may find its home ultimately in the botanic garden) will serve as centers of study of the pure science of botany. This will readily find its application to agriculture, to forestry, to economics, and in various other lines present and future. I am convinced that it is in the best interest of any state that can possibly afford to do so to encourage and liberally endow the central establishment where the pure science of botany is pursued, and to continue that encouragement and endowment, even though results of immediate practical use do not appear to be flowing from it at any given moment. For in these matters it is impossible to forecast what will and what will not be eventually of practical use. And in any case as educational centers the purely botanical establishments will always retain their important function of supplying that exact instruction, without which none can pursue with full effect a calling in the applied branches.

We may now turn from generalities to certain special points of interest in your peculiar flora which happen to have engaged my personal attention. They center round a few rare and isolated plants belonging to the Pteridophyta, a division of the vegetable kingdom which there is every reason to believe to have appeared early in the history of evolution. But though the type may be an ancient one it does not follow that every representative of it preserves the pristine features intact. Throughout the ages members of these early families may themselves have progressed. And so among them to-day we may expect to find some which preserve the ancient characters more fully than others. The former have stood still, and may be found to compare with curious exactitude with fossils even of very early date. The latter have advanced, and though still belonging to the ancient family, are by their modifications become essentially modern representatives of it. For instance, the fern *Angiopteris* has a sorus which very exactly matches sori from the Paleozoic period, and it may accordingly be held to be a very ancient type of fern. On the other hand, the genera *Asplenium*, or *Polypodium*, include ferns of a type which has not been recognized from early fossil-bearing rocks, and they may be held to be essentially modern. But still all of them clearly belong to the family of the ferns.

In the Australian flora only three of the four divisions of the Pteridophyta are represented. For, curiously enough, there does not appear to be any species on your continent of the widely spread genus *Equisetum*, the only living genus of that great phylum of the Equisetales, which figured so largely in the Paleozoic period; and this notwithstanding that one species (*E. debile*) is present among the Polynesian Islands. But all the three other divisions of the Pteridophyta are included, and are represented in each case by plants which show peculiar and, probably for the most part, archaic characters. I propose to sketch before you very briefly the points of interest which the more notable of these archaic types present. Some justification may be found for my doing so because nearly all of them have been submitted to detailed study in my laboratory in Glasgow, and much of the work has been done upon material supplied to me by your own botanists. I take this opportunity of offering to them collectively my hearty thanks.

The tenure by Dr. Treub of the office of

director of the botanic gardens of Buitenzorg was rendered famous by his personal investigations, and chiefly by his classical researches on the Lycopods. These were followed up by other workers, and notably by Bruchmann; so that we now possess a reasonable basis for comparison of the different types of the family as regards the prothallus and embryology, as well as of the sporophyte plant; and all of these characters must be brought together as a basis for a sound conclusion as to their phyletic seriation. The most peculiar living Lycopods are certainly *Isoëtes* and *Phylloglossum,* both of which are found in Australia. The former need not be specially discussed here, as it is a practically world-wide genus. It must suffice to say that it is probably the nearest living thing to the fossils *Lepidodendron* and *Sigillaria,* and may be described as consisting of an abbreviated and partially differentiated *Lepidostrobus* seated upon a contracted stigmarian base.

But *Phylloglossum,* which is peculiar to the Australasian region, naturally claims special attention. The plant is well known to botanists as regards its external features, its annual storage tuber, its leafy shoot with protophylls and roots, and its simple shaft bearing the short strobilus of characteristic Lycopod type. But its prothallus has never been properly delineated, though it was verbally described by Dr. A. P. W. Thomas in 1901.[2] Perhaps the completed statement may have been reserved as a pleasant surprise for this meeting. But the description of thirteen years ago clearly shows its similarity to the type of *Lycopodium cernuum.* The sporophyte compares rather with *L. inundatum.* Both of these are species which, though probably not the most primitive of the genus, are far from being the most advanced. As all botanists know, the question of the position of *Phylloglossum* chiefly turns upon the view we take of the annual tuber and its protophylls. Treub, finding similar conditions in certain embryos of Lycopods, called it a "protocorm," and believed that he recognized in it an organ of archaic nature, which had played an important part in the early establishment of the sporophyte in the soil, physiologically independent of the prothallus. I must not trouble you here with the whole argument in regard to this view. Facts which profoundly affect the conclusion are those showing the inconstancy of occurrence of the organ. Mr. Holloway has recently described it as of unusual size in your native *L. laterale,* as it is also in *L. cernuum.* But it is virtually absent in those species which have a large intraprothallial foot, such as *L. clavatum,* as well as in the genus *Selaginella* and in *Isoëtes.* In *L. Selago,* which on other grounds appears to be primitive, there is no "protocorm." Such facts appear to me to indicate caution. They suggest that the "protocorm" is an opportunist local swelling of inconstant occurrence, which, though biologically important in some cases, is not really primitive.

If this is the comparative conclusion, then our view will be that *Phylloglossum* is a type of Lycopod which has assumed, perhaps relatively recently, a very practical mode of annual growth. Related, as it appears to be on other points, with the *L. inundatum* group of species, it has bettered their mode of life. *L. inundatum* dies off each year to the very tip of its shoot, so that only the bud remains to the following season. It is notable that Goebel has described long ago how the young adventitious buds of this species start with small "protocorms," quite like those of *Phylloglossum* itself, or like the embryo of *L. cernuum.* And so we may conclude that in *Phylloglossum* a tuberous development, containing a store to start the plant in the spring,

[2] *Proc. Roy. Soc.,* Vol. 69, p. 285.

has been added to what is already seen normally each year in *L. inundatum*. And this mode of life of *Phylloglossum* begins, as Thomas has shown, with its embryo. This appears to me to be a rational explanation of the "protocorm" of *Phylloglossum;* but it robs the plant of much of its theoretical interest as an archaic form.

The phylum of the Sphenophyllales was originally based on certain slender straggling plants of the genus *Sphenophyllum* found in the Paleozoic rocks; but apparently died out in the Permian period. Your native genera *Tmesipteris* and *Psilatum* were ranked by earlier botanists with the Lycopods, but a better acquaintance with their details, and especially the examination of numerous specimens on the spot, indicated a nearer affinity for them with the Sphenophyllales. It was Professor Thomas who, in 1902, first suggested that the Psilotaceæ might be included with the Sphenophyllæ in the phylum of the Sphenophyllales, and I personally agree with him. Dr. Scott, however, dissents, on the ground that the leaves are persistently whorled in the sphenophylls, while they are alternate in the Psilotaceæ; and while the former branch monopodially the latter dichotomize. But since both of these characters are seen to be variable within the not far distant genus *Lycopodium,* the differences do not seem to me to be a sufficient ground for keeping them apart as the separate phyla of Sphenophyllales and Psilotales. Whatever degree of actual relation we trace, such plants as *Tmesipteris* and *Psilotum* are certainly the nearest living representatives of the Sphenophylleæ, a fact which gives them a special distinction. The Psilotaceæ also stand alone in the fact that they are the only family of the Pteridophytes in which the gametophyte is still unknown. They produce spores freely, but there the story stops. Any young Australian who hits upon the way to induce these recalcitrant spores to germinate, and to produce prothalli and embryos, or who found their prothalli and embryos in the open, would have before him a piece of work as sensational as anything that could be suggested. Further, I am told that *Tmesipteris* grows here on the matted stumps of *Todea barbara.* I shall be alluding shortly to the fossil Osmundaceæ. May we not venture to fancy the possibility of some fossil *Osmunda* being found which has embalmed for us among its roots a Mesozoic or even a Tertiary Sphenophyll? And thus a link might be found between the Paleozoic types and the modern Psilotaceæ, not only in time, but even in character.

We pass now to the last phylum of the Pteridophyta, the Filicales. I am bound to say that for me its interest far outweighs that of others, and for this reason: that it is represented by far the largest number of genera and species at the present day, while there is a sufficiently continuous and rich succession of fossil forms to serve as an efficient check upon our comparative conclusions.

Since 1890 it has been generally accepted that the Eusporangiate ferns (those with more bulky sporangia) were phyletically the more primitive types, and the Leptosporangiate (those with more delicate sporangia) the derivative, and in point of time later. The fossil evidence clearly upholds this conclusion. But, further, it has been shown that the character of the sporangium is merely an indicator of the general constitution of the plants in question. Where it is large and complex, as in the Eusporangiates, all the apical segmentations are, as a rule, complex, and the construction of the whole plant relatively bulky. Where the sporangium is delicate and relatively simple all the apical segmentations follow suit, and the construction of the

plant is on a less bulky model. On this basis we may range the ferns roughly as a sequence, starting from relatively bulky types of the distant past, and progressing to the more delicate types of the present day. The large majority of the living species belong naturally to the latter. But the former are still represented by a few genera and species which, like other survivals from a distant past, are frequently of very restricted distribution.

An interesting feature of the Australasian flora is that a considerable number of these relatively ancient forms are included in it. Thus the Marattiaceæ are represented by one species of *Marattia* and one of *Angiopteris*. Though in themselves interesting, they will be passed over without special remark, as they are very widely spread tropical forms.

All the three genera of Ophioglossaceæ are included, there being two species of *Ophioglossum* and two of *Botrychium*, while *Helminthostachys* is recorded from Rockingham Bay. This family is coming more than ever to the front in our comparisons, owing to their similarity in various aspects to the ancient Botryopterideæ. Though the Ophioglossaceæ have no secure or consecutive fossil history, still they may now be accepted as being very primitive but curiously specialized ferns. Perhaps the most interesting point recently detected in them is the suspensor found by Dr. Lyon in *Botrychium obliquum*, and by Dr. Lang in *Helminthostachys*. This provides a point for their comparison with the similar embryonic condition in *Danæa*, as demonstrated by Professor Campbell. The existence of a filamentous initial stage of the embryo is thus shown for three of the most primitive of living ferns. Its existence in all of the Bryophytes, and in most of the Lycopods, as well as in the seed-plants, is a very significant fact. Dr. Lang suggests that "the suspensor represents the last trace of the filamentous juvenile stage in the development of the plant, and may have persisted in the seed-plants from their filicineous ancestry." Such a possibility would fit singularly well with the theory of encapsulation of the sporophyte in the venter of the archegonium.

The representation of the ancient family of the Osmundaceæ in the Australasian flora is very fine, though limited to five living species, while *Osmunda* itself is absent. It is, however, interesting that the family dates back locally to early fossil times. It was upon two specimens of *Osmundites* from the Jurassic rocks in the Otago district of New Zealand that the series of remarkable papers on "The Fossil Osmundaceæ" by Kidston and Gwynne-Vaughan was initiated. It is no exaggeration to say that these papers have done more than any other recent researches to promote a true understanding not only of the Osmundaceæ themselves, but of fern-anatomy as a whole. They have placed the stellar theory in ferns for the first time upon a basis of comparison, checked by reference to stratigraphical sequence. It would be leading us too far for me to attempt here to summarize the important results which have sprung from the study of those fossils, so generously placed by Mr. Dunlop in the hands of those exceptionally able to turn them to account. It must suffice to say that it is now possible to trace as a fairly continuous story the steps leading from the protostelic state to the complex condition of the modern *Osmunda*. These facts and conclusions are to be put in relation with the anatomical data fast accumulating from the Ophioglossaceæ in the hands of Professor Lang and others. From such comparisons a rational explanation of the evolutionary steps leading to the complex stellar state in ferns at large begins to emerge. This is no mere tissue of

surmise, for the conclusions are based on detailed comparison of types occurring in lower horizons with those of the present day.

I must pass over with merely nominal mention your interesting representation of the ancient families of Schizæaceæ, Gleicheniaceæ and Hymenophyllaceæ, all of which touch the very foundations of any phyletic system of ferns. Also the magnificent array of Dicksonieæ and Cyatheæ, and of the important genus *Lindsaya*—ferns which take a rather higher position in point of view of descent. But I am bound to devote a few moments to one of your most remarkable ferns, endemic in New Zealand—the monotypic *Loxsoma.*

This species has peculiar characters which justify its being regarded systematically as the sole representative of a distinct tribe. It is also restricted geographically to the North Island of New Zealand. These facts at once suggest that it is an ancient survival, a conclusion with which its solenostelic axis, its sorus and sporangium, and its prothallus readily accord. I have lately shown that the Leptosporangiate ferns fall into two distinct series, those in which the origin of the sorus is constantly superficial, and those in which it is as constantly marginal. *Loxsoma* is one of the "Marginales." It shares this position with the Schizæaceæ, Thyrsopterideæ, Hymenophyllaceæ and Dicksonieæ, and the derivatives Davalieæ and Oleandreæ. Its nearest living relative is probably *Thyrsopteris,* which is again a monotypic species endemic in the island of Juan Fernandez. There is also a probable relation to the genus *Loxsomopsis,* represented by one species from Costa Rica, and a second lately discovered in Bolivia. Such a wide and isolated distribution of types, which by their characters are certainly archaic, suggests that we see in them the relics of a Filicineous state once widely spread, which probably sprang from a Schizæaceous source, and with them represent the forerunners of the whole marginal series. If we look for further enlightenment from the fossils, it is to the secondary rocks that we should turn. It is then specially interesting that Mr. Hamshaw Thomas has lately described a new Jurassic fern, *Stachypteris Halli,* which has marginal sori, and is probably referable to a position like that of *Loxsoma* and *Thyrsopteris,* between the Schizæaceæ and the Dicksonieæ. In fact the gaps in the evolutionary series of the Marginales are filling up. We may await with confidence fresh evidence from the Jurassic period, upon which Professor Seward is directing an intensive interest.

I should be ungrateful indeed if I did not mention your very full representation of Blechnoid ferns: for developmental material of several of these has been sent to me by Dr. Cockayne, and others from New Zealand. A wide comparative study of the genus has led me to somewhat unexpected results in regard to the plasticity of the sorus, its phyletic fusions and disruptions. The consequent derivative forms are seen in *Woodwardia* and *Doodya,* on the one hand, and on the other in *Scolopendrium* and *Asplenium.* These ferns together constitute a coherent phylum springing ultimately from a Cyatheoid source. The details upon which this conclusion is based I hope to describe in a separate communication to the section.

And lastly, the Hydropterideæ deserve brief mention. Represented in your flora by two species of *Azolla,* and one each of *Marsilea* and *Pilularia,* they typify a condition which must theoretically have existed among ferns in very early times, viz., the heterosporous state. But hitherto, notwithstanding the existence of our living Hydropterideæ, no fossil fern with microscopic

structure preserved had been detected from the primary rocks, showing this intermediate condition between the homosporous type and that of the Pteridosperms. This unsatisfactory position has now been resolved by Professor Lignier, who has recently described, under the name of *Mittagia,* a fossil from the Lower Westphalian, which bore sori of which the sporangia contained four megaspores, while the outer tissues of the sporangia resembled those of *Lagenostoma.* Pending the discovery of further specimens, these observations may be welcomed as filling with all probability a conspicuous gap in the evolutionary sequence of known forms.

From the rapid survey which I have been able to give you of some of the more notable Australasian ferns of relatively archaic type, it is clear that they have a very interesting and direct bearing upon the phylesis of ferns. The basis upon which conclusions as to phyletic sequence are arrived at is at root that of the natural system of classification generally—the recognition not of one character, or of two, but of as many as possible, which shall collectively serve as criteria of comparison. In the case of the Filicales we may use the characters of:—

(i) External form.
(ii) Constitution, as shown by simple or complex segmentation.
(iii) Dermal appendages, hairs or scales.
(iv) Stellar structure, simple or complex.
(v) Leaf-trace, coherent or divided.
(vi) Soral position.
(vii) Soral construction.
(viii) Indusial protections.
(ix) Sporangial structure and mechanism of dehiscence.
(x) Spore-output.
(xi) Spore-form and character of wall.
(xii) Form of prothallus.
(xiii) Position of the sexual organs, sunken or superficial.
(xiv) Number of spermatocytes and and method of dehiscence.
(xv) Embryology.

In respect of all these criteria progressions of character may be traced as illustrated by known ferns, and probably other criteria may emerge as study progresses. In each case, upon a footing of general comparison, checked as opportunity offers by reference to the stratigraphical sequence of the fossils, it may be possible to distinguish with some degree of certainty what is relatively primitive from what is relatively advanced. Thus, the protostele is generally admitted to be more primitive than the dictyostele, the simple hair than the flattened scale, and a high spore-output than a low one.

Applying the conclusions thus arrived at in respect to the several criteria, it becomes possible upon the sum of them to lay out the species and genera of ferns themselves in series, from the primitive to the advanced. In proportion as the progressions on the basis of the several criteria run parallel, we derive increased assurance of the rectitude of the phyletic sequences thus traced, which may finally be clinched, as opportunity offers, by reference to the stratigraphical occurrence of the corresponding fossils. This is in brief the phyletic method, as it may be applied to ferns. It may with suitable variation be applied to any large group of organisms, though it is seldom that the opportunities for such observation and argument are in any sense commensurate with the requirements. Perhaps there is no group of plants in which the opportunities are at the moment so great as in the Filicales, and they are yielding highly probable results from its application.

The greatest obstacle to success is found

in the prevalence of parallel development in phyla which are believed to have been of distinct origin. This is exemplified very freely in the ferns, and the systematist has frequently been taken in by the resemblances which result from it. He has grouped the plants which show certain common characters together as members of a single genus. Sir William Hooker in doing this merged many genera of earlier writers. His avowed object was not so much to secure natural affinity in his system as readiness of identification: and consequently in the "Synopsis Filicum" there are nominal genera which are not genera in the phyletic sense at all. For instance, *Polypodium* and *Acrostichum,* as there defined, may be held from a phyletic point of view to be collective groupings of all such ferns as have attained a certain state of development of their sorus; and that they are not true genera in the sense of being associated by any kinship of descent: this is shown by the collective characters of the plants as a whole. Already at least four different phyletic sources of the Acrostichoid condition have been recognized, and probably the sources of the Polypodioid condition are no fewer. Such "genera" represent the results of a phyletic drift, which may have affected similarly a plurality of lines of descent. It will be the province of the systematist who aims at a true grouping according to descent to comb out these aggregations of species into their true relationships. This is to be done by the use of wider, and it may be quite new criteria of comparison. Advances are being made in this direction, but we are only as yet at the beginning of the construction of a true phyletic grouping of the Filicales. The more primitive lines are becoming clearer: but the difficulty will be greatest with the distal branches of the tree. For these represent essentially the modern forms, they comprise the largest number of apparently similar species, and in them parallel development has been most prevalent.

If this difficulty be found in such a group as the Filicales, in which the earlier steps are so clearly indicated by the related fossils, what are we to say for the Angiosperms? Our knowledge of their fossil progenitors is very fragmentary. But they are represented now by a multitude of forms, showing in most of their features an irritating sameness. For instance, vascular anatomy, that great resource of phyletic study in the more primitive types, has sunk in the Angiosperms to something like a dead level of uniformity. There is little variety found in the contents of embryo-sacs, in the details of fertilization, or in embryology. Even the ontogeny as shown in the seedling stages affords little consolation to the seeker after recapitulation. On the other hand, within what are clearly natural circles of affinity there is evidence of an extraordinary readiness of adaptability in form and structure. Such conditions suggest that we see on the one hand the far-reaching results of parallel development, and on the other the effects of great plasticity at the present day, or in relatively recent times. Both of these are points which prevent the ready tracing of phyletic lines. In the absence of reliable suggestions from paleontology, the natural consequence is the current state of uncertainty as to the phyletic relations of the Angiosperms.

Various attempts have been or are being made to meet the difficulty. Some, on the basis of the recent observations of Wieland and others, are attempting along more or less definite monophyletic lines to construct, rather by forcible deduction than by any scientific method of induction, an

evolutionary story of the Angiosperms. I do not anticipate that any great measure of success, beyond what is shown in a very polysyllabic terminology, and an appearance of knowing more than the facts can quite justify, will attend such efforts. It would seem to me to be more in accord with the dictates of true science to proceed in a different way, as indeed many workers have already been doing. To start not from preconceptions based upon limited paleontological data, but from an intensive study of the living plants themselves. To widen as far as possible the criteria of comparison, by making, for instance, every possible use of cellular, physiologico-chemical, and especially secretory detail, and of minor formal features, such as the dermal appendages, or by initiating a new developmental morphology of the flower from the point of view of its function as a whole; and with its physiological end clearly in sight, viz., the maturing, nourishing, and placing of new germs. To make on some such basis intraordinal, and intrageneric comparisons with a view to the phyletic seriation of closely related forms; and so to construct probable short series, which may subsequently be associated into larger phyletic groupings. This should be checked wherever possible by physiological probability. A keen eye should be kept upon such information as geographical distribution and paleontology may afford, and especially upon the fossils of the Mesozoic Period. What is above all needed for success among the Angiosperms is new criteria of comparison, to meet the far-reaching difficulties that follow from parallel development and recent adaptation. If some such methods be adopted, and strenuously pressed forward, the task should not appear hopeless, though it can not be anything else than an arduous one.

I can not conclude without some remark on the bearing of parallel or convergent development, so fully exemplified in the Filicales, upon the question of the genesis of new forms. Any one who examines, from the point of view suggested in this address, the larger and well-represented divisions of the vegetable kingdom must be impressed with the extraordinary dead level of type to which their representatives have attained. In most of these divisions the phyletic history is obscured, partly by the absence of any consecutive paleontological record, but chiefly by the want of recognized criteria for their comparison. This is very prominently the case for the mosses, and the Angiosperms.

But it may be doubted whether these large groups differ in any essential point, in respect of the genesis of their multitudinous similar forms, from the Filicales, in which the lines of descent are becoming clearer through additional knowledge. Suppose that we knew of no fossil ferns; and that none of the early fern-types included under the term "Simplices" had survived in our living flora: and that the Filicales of our study consisted only of the 2,500 living species of the old undivided genera of *Polypodium*, *Asplenium*, *Aspidium* and *Acrostichum*. Then the phyletic problem of the Filicales would appear as obscure as does that of the mosses, or of the Angiosperms of the present day. They would present, as these great groups now do, an apparent dead level of sameness in type, though the phyletic starting-points in each may have been several and distinct. There is every reason to suppose that in the phylesis of the mosses or the Angiosperms also there has been a parallel, and even a convergent, development of the same nature as that which can be cogently traced in the Filicales: but that it is obscured by the obliteration of the early stages. Internal evidence from their com-

parative study fully justifies this conclusion. How, then, are we to regard this insistent problem of parallelism and convergence from the point of view of genetic study?

A belief in the "inheritance of acquired characters," or, as it is sometimes expressed, "somatic inheritance," is at present out of fashion in some quarters. But though powerful voices may seem to have forced it for the moment into the background, I would take leave to point out that such inheritance has not been disproved. All that has been done, so far as I understand the position, is to show that the evidence hitherto advanced in support of it is insufficient for a positive demonstration. That is a very different thing from proving the negative. We hear of "fluctuating variations" as distinct from "mutations"; and it is asserted that the former are somatic, and are not inherited, while the latter are inherited. This may be held as a useful terminological distinction, in so far as it accentuates a difference in the heritable quality. But it leaves the question of the origin of these heritable "mutations" quite open. At the present moment I believe that actual knowledge on this point is very like a complete blank. Further, it leaves indefinite the relative extent and proportion of the "mutations." It is commonly held that mutations are considerble deviations from type. I am not aware that there is any sufficient ground for such a view. It may probably have originated from the fact that the largest are most readily observed and recognized as reappearing in the offspring. But this is no justification for ignoring the possibility of all grades of size or importance of heritable deviations from type.

On the other hand, adaptation, with its consequence of parallel or even convergent development in distinct stocks, is an insistent problem. The real question is, What causes are at work to produce such results? They are usually set down to the selection of favorable divergences from type out of those produced at random. But the prevalence of parallelism and convergence suggests that those inheritable variations, which are now styled "mutations," are not produced at random. The facts enforce the question whether or not they are promoted and actually determined in their direction, or their number, or their quality, in some way, by the external conditions. Parallelism and convergence in phyletic lines which are certainly distinct impress the probability that they are. Until the contrary is proved it would, in my opinion, be wiser to entertain some such view as a working hypothesis than positively to deny it. Such a working hypothesis as this is not exactly the same as a "mnemic theory," though it is closely akin to it. It may perhaps be regarded as the morphologist's presentation, while the mnemic theory is rather that of the physiologist. But the underlying idea is the same, viz., that the impress of external circumstance can not properly be ruled out in the genesis of inheritable characters, simply because up to the present date no definite case of inheritance of observable characters acquired in the individual lifetime has been demonstrated. Of course, I am aware that to many this is flat heresy. At this meeting of the association it amounts almost to high treason. I plead guilty to this heresy, which may by any sudden turn of observation be transformed into the true faith. I share it in whole or in part with many botanists, with men who have lived their lives in the atmosphere of experiment and observation found in large botanical gardens, and not least with a former president of the British Association—viz., Sir Francis Darwin.

It is noteworthy how large a number of botanists dissent from any absolute negation of the influence of the environment upon the genesis of heritable characters. Partly this may be due to a sense of the want of cogency of the argument that the insufficiency of the positive evidence hitherto adduced justifies the full negative statement. But I think it finds its real origin in the fact that in plants the generative cells are not segregated early from the somatic. In this respect they differ widely from that early segregation of germ-cells in the animal body, to which Weismann attached so much importance. The fact is that the constitution of the higher plants and of the higher animals is in this, as in many other points, radically different, and arguments from the one to the other are dangerous in the extreme. Those who interest themselves in evolutionary questions do not, I think, sufficiently realize that the utmost that can be claimed is analogy between the higher terms of the two kingdoms. Their phyletic separation certainly dates from a period prior to that of which we have any knowledge from the fossil record. Let us give full weight to this fact, as important as it is indisputable. The early definition of germ-cells in the animal body will then count for nothing in the evolutionary problem of plants. Moreover, we shall realize that the plant, with its late segregation of germ-cells, will present the better field for the inquiry whether, and how far, the environment may influence or induce divergences from type. From this point of view the widespread opinion among botanists that the environment in some sense determines the origin and nature of divergences from type in plants should command a special interest and attention.

I must now draw to a close. I have passed in review some of your more notable plants, and pointed out how the Australsian flora, whether living or fossil, includes in unusual richness those evidences upon which the fabric of evolutionary history is being based. I have indicated how this history in certain groups is showing ever more and more evidence of parallel development, and that such development, or convergence, presses upon us the inquiry into the methods of evolutionary progress. The illustrations I have brought forward in this address clearly show how important is the positive knowledge derived from the fossils in checking or confirming our decisions. Paleophytology is to be prized not as a separate science, as, with an enthusiastic view restricted between blinkers, a recent writer has endeavored to enforce. To treat it so would be to degrade it into a mere side alley of study, instead of holding it to be the most positive line that we possess in the broad avenue of botanical phylesis. An appreciation of such direct historical evidence is no new idea. Something of the same sort was felt by Shakespeare three centuries ago, and it remains the same to-day. Nay more:—it may lead us even to forecast future possibilities. In following our evolutionary quest in this spirit we shall find that we are indeed—

> Figuring the nature of the times deceased,
> The which observed, a man may prophesy
> With a near aim, of the main chance of things
> As yet not come to life.
> (King Henry IV., Part II., Act iii, Scene i.)

F. O. Bower

THE DECREASING BIRTH RATE OF THE GERMAN EMPIRE

During the 30 years following the war with France the population of Germany increased enormously while the population of France remained almost stationary. But at the beginning of the new century the birth rate in Germany began to decline and is still declining at a rapid rate. In an article in No. 18 of

the *Münchener Medizinische Wochenschrift* Dr. von Gruber gives some remarkable facts about the decreasing birth rate in Germany, which are the more interesting as the same causes are underlying a decreasing birth rate in certain classes and certain regions of the United States.

Von Gruber shows that while the number of marriages in Germany remained about the same (80 per 10,000 inhabitants) the birth rate sank from 370 in 1900 to 310 in 1910. This decrease is especially marked in the cities and industrial regions. In Berlin the number of births per 10,000 inhabitants decreased from 149 in 1876 to 93 in 1912. But not only the cities, the country districts, too, show a gradual decrease in the birth rate. Especially is this noticeable in the districts adjoining large cities. In general this decrease is more marked in regions with a predominantly Protestant population, and with regard to politics, in those election districts which send regularly a socialist member to the Reichstag.

Considering the causes of this general decline of the birth rate von Gruber thinks that it is principally due to prevention of conception. He recognizes the fact, however, that this decrease is to some extent unintentional. Many of the best families die out though children are ardently desired. The causes of this phenomenon are not fully known, but alcoholism and the venereal diseases are probably the principal underlying causes.

Of special significance is the insufficient increase of the birth rate among the intellectual classes. For the safety, progress and prosperity of any nation a sufficient number of persons who are leaders of the people is necessary. Without her great statesmen and generals, her leaders in commerce and industry, in the arts and sciences, the enormous development of modern Germany would have been impossible. Both Greece and Rome perished from a steadily decreasing birth rate of the ruling race, and it is a remarkable fact that during the decline of the Roman Empire no great statesmen and generals, no great thinkers, artists and scientists, appeared. It was a period of complete stagnation. The same is true of the declining periods of Greek history.

In view of the more difficult living conditions of modern times von Gruber recognizes the right of the parents to limit the number of their children, but this limitation should not be carried so far as to endanger the safety of the state. The desire for wealth and luxury, the movement of woman's emancipation, the disappearance of a deep religious sentiment are the most destructive agencies in modern society. The destructive effects of the abandonment of old orthodox beliefs is shown by the fate of the Jewish race. Under the faithful observation of the Mosaic law the Jews maintained the strength and vigor of their race through thousands of years in the face of all opposition and persecution, but in modern times the Jews, at least so far as Germany is concerned, are threatened with extinction. They have abandoned their ancient faith, they hold the most advanced views on life, their writers are the most fanatic agitators for the overthrow of marriage and the established order of sexual relations. The chase after money, the thirst for power and pleasure, has blinded them to the fact that they are facing extinction through race suicide. These conditions are especially marked among the Jews of Berlin. From 1875 to 1910 the Jews of Berlin increased 100 per cent., but the number of Jewish births decreased during the same period 11 per cent. In 1905 the number of births per 1,000 Jewish women in the child-bearing age was only 56.8. At present their natality is only 14 per 1,000. Still less is the natality among the Jews of Bohemia and Moravia, where, according to recent statistics, it sank to 12.9 per 1,000, the lowest birth rate known among any race. This enormous decrease of births among the Jews shows that the phenomenon is not due to poverty and indigence, for the Berlin Jews are among the best situated people of that city.

A reasonable increase in population is absolutely necessary for any people to maintain its position among the nations. If the two-children system should be carried out generally,

von Gruber finds that the descendants of one million people would after 100 years only amount to 347,000 souls.

To counteract the modern tendency to race suicide von Gruber proposes (1) Improvement of the economic condition of families with many children by proper laws. (2) Limitation of the economic advantages of childlessness. (3) Suppression of those agencies which, for pecuniary gains, spread the vice of race suicide. He takes an energetic stand against those modern "reformers" who would loosen the marriage ties. He considers the modern monogamous marriage the only basis of healthy sexual relations. Freedom in marriage would become "free love" and end in general sterility. He condemns the claim of the law committee of the Federation of German Women, who maintain that "as a free person woman is the mistress over her own body and may destroy a germ which, in its initial stage, is an inseparable part of her own body." The ideal of woman's emancipation has never been more nearly approached than in Imperial Rome, where sterility was a general phenomenon.

It is nothing but just that the state bear a part of the expenses of parents with a numerous family. Parents who have three or more normal and healthy children under 14 years should be paid a monthly contribution, and if they have raised three or more children they should receive an old age pension when they have reached the age of 60 years. Besides these economic advantages von Gruber would give a father of three or more children a plural vote at all elections proportional to the number of his children. A large portion of the sums expended in the assistance of families with many children could be procured by a tax on the incomes of bachelors and parents with few or no children. Von Gruber proposes severe laws against the "propaganda for the two-children system," as well as severe penalties on criminal abortion and on the advertisement and sale of drugs and other means for the prevention of conception.

A. Allemann

PATENT MEDICINES IN GREAT BRITAIN

Largely through the efforts of the American Medical Association and through legislation by Congress some progress has been made in the United States in limiting the dangers from the sale and use of secret medicines. The conditions are now worse in Great Britain than in this country, and in 1912 the government appointed a select committee which has just issued an abstract of its report. It finds that there is a large and increasing sale of patent and proprietary remedies and appliances and of medicated wines; that this constitutes a grave and widespread public evil and that "an intolerable state of things," requires new legislation to deal with it, rather than merely the amendment of existing laws. Legislation is recommended as follows:

1. That every medicated wine and every proprietary remedy containing more alcohol than that required for pharmacological purposes, be required to state upon the label the proportion of alcohol contained in it.

2. That the advertisement and sale (except the sale by a doctor's order) of medicines purporting to cure the following diseases be prohibited: Cancer, consumption, lupus, deafness, diabetes, paralysis, fits, epilepsy, locomotor ataxy, Bright's disease, rupture (without operation or appliance).

3. That all advertisements of remedies for diseases arising from sexual intercourse or referring to sexual weakness be prohibited.

4. That all advertisements likely to suggest that a medicine is an abortifacient be prohibited.

5. That it be a breach of the law to change the composition of a remedy without informing the Department of the proposed change.

6. That fancy names for recognized drugs be subject to regulation.

7. That the period of validity of a name used as a trade mark for a drug be limited, as in the case of patents and copyrights.

8. That it be a breach of the law to give a false trade description of any remedy, and that the following be a definition of a false trade description: "A statement, design, or device regarding any article or preparation, or the drugs or ingredients or substances contained therein, or the curative or therapeutic effect thereof, which is false or misleading in any particular." And that the onus of proof that he had reasonable ground for belief in the truth of any statement by him regard-

ing a remedy, be placed upon the manufacturer or proprietor of such remedy.

9. That it be a breach of the law: (*a*) To enclose with one remedy printed matter recommending another remedy. (*b*) To invite sufferers from any ailment to correspond with the vendor of a remedy. (*c*) To make use of the name of a fictitious person in connection with a remedy. (But it should be within the power of the department to permit the exemption of an old-established remedy from this provision.) (*d*) To make use of fictitious testimonials. (*e*) To publish a recommendation of a secret remedy by a medical practitioner unless his or her full name, qualifications and address be given. (*f*) To promise to return money paid if a cure is not effected.

THE TWENTY-FIFTH ANNIVERSARY OF THE MISSOURI BOTANICAL GARDEN

THE Missouri Botanical Garden has made arrangements to celebrate its twenty-fifth anniversary on October 15 and 16. The war in Europe may interfere with the attendance of some of the foreign delegates, but it is known that all of those on the program will make every effort to come and, in case this is impossible, their papers will be sent in time to be read. The program is as follows:

Thursday, October 15

10:30 A.M. Automobile ride through the city for delegates and visiting scientists.

1:00 P.M. Lunch at the garden.

2:00 P.M. Graduate lecture room:

Address of welcome: Director George T. Moore.

The History and Functions of Botanical Gardens: Assistant Director Arthur W. Hill, Royal Botanic Gardens, Kew, England.

The Phylogenetic Taxonomy of the Flowering Plants: Professor Charles E. Bessey, University of Nebraska, Lincoln, Nebraska.

Development of the Norwegian Flora Since the Ice Age: Professor N. Wille, University of Christiania, Christiania, Norway.

The Vegetation of Mona Island: Director in Chief, N. L. Britton, New York Botanical Garden, Bronx Park, N. Y.

The Scientific Significance of the Imperial Botanic Garden of Peter the Great, with Special Reference to the Flora of Asia: Dr. Wladimir I. Lipsky, Jardin Impérial Botanique de Pierre le Grand, St. Petersburg, Russia.

Comparative Carpology of Cruciferæ with Vesicular Fruits—Some General Biological and Systematic Conclusions: Director J. Briquet, Conservatoire et du Jardin Botaniques de la Ville Genève, Geneva, Switzerland.

The Origin of Monocotyledony: Professor John M. Coulter, University of Chicago, Chicago, Illinois.

8:30–11:30 P.M. Reception. Director's Residence.

Friday, October 16

10:30 A.M. Special personally conducted trip through the conservatories and grounds of the garden. Opportunity will be given during the morning for those who wish to spend time in the library or herbarium.

12:30 P.M. Lunch at the Garden.

1:30 P.M. Graduate lecture room:

Recent Investigations on the Protoplasm of Plant Cells and Its Colloidal Properties: Professor Frederick Czapek, Physiologisches Institut der K. K. Deutschen Universität, Prag, Austria.

Experimental Modification of the Germ Plasm: Director D. T. Macdougal, Department of Botanical Research, Carnegie Institution of Washington, Tucson, Arizona.

Hormone im Pflanzenreich: Director Hans Fitting, Botanisches Anstalten der Universität Bonn, Bonn, Germany.

The Law of Temperature Connected with the Distribution of Marine Algæ: Professor William A. Setchell, University of California, Berkeley, California.

Ueber Formbildung und Rhythmik der Pflanzen: Director George Klebs, Botanisches Institut Universität Heidelberg, Heidelberg, Germany.

Phylogeny and Relationships in the Ascomycetes: Professor George F. Atkinson, Cornell University, Ithaca, New York.

The Organization of a Mushroom: Professor A. H. Reginald Buller, University of Manitoba, Winnipeg, Canada.

A Conspectus of Bacterial Diseases in Plants: Dr. Erwin F. Smith, Bureau of Plant

Industry, U. S. Department of Agriculture, Washington, D. C.

7:30 P.M. Trustees' Banquet. Liederkranz Club.

SCIENTIFIC NOTES AND NEWS

THE British government has appointed a committee to consider questions in relation to the supply of drugs as affected by the war. The members of the committee are: Dr. J. Smith Whitaker, Sir Thomas Barlow, Sir Lauder Brunton, Dr. A. Cox, Professor A. R. Cushny, Dr. E. Rowland Fothergill, Dr. B. A. Richmond, Dr. F. J. Smith, Dr. W. Hale White, with Dr. E. W. Adams as secretary.

DR. WILLIAM H. WELCH, of the Johns Hopkins University, president of the National Academy of Sciences, is among the large number of American men of science detained on the continent by the war.

DR. EWALD HERING, professor of physiology at Leipzig, celebrated on August fifth his eightieth birthday.

THE Paris Academy of Sciences has awarded a prize of $600 to Dr. H. Vincent, for his work on typhoid fever.

DR. JOSEF MELAN, professor of bridge building at Prague, has been given an honorary doctorate of engineering by the Technical School at Brunn.

DR. FRANZ FISCHER has been appointed head of the newly established institute for fuel investigation at Mülheim.

DR. S. W. PATTERSON has been engaged by the government of Madras to undertake an investigation into the causation, prevention and possible cure of diabetes. The sum of 50,000 rupees has been given by the Raja of Pithapuram for the purpose.

DR. G. ANGENHEISTER has been appointed director of the Geophysical Observatory at Apia, Samoa.

DR. VIRGIL H. MOON, of the Memorial Institute for Infectious Diseases, Chicago, has been appointed head of the pathological department.

THE convocation orator at the University of Chicago on August 28 was Dr. Roscoe Pound, professor of jurisprudence in Harvard University and formerly professor of law in the University of Chicago. The subject of his address was "Legalism." Dr. Pound was for eleven years director of the Botanical Survey of the state of Nebraska. He is a fellow of the American Association for the Advancement of Science and a member of the Botanical Society of America.

LIEUTENANT SEDOFF, who two years ago headed an Arctic expedition to Franz Josef Land, fell ill and died, it is said, in an effort to reach the North Pole. Survivors of the expedition have arrived at Archangel.

DR. ALFRED HEGAR, formerly professor of medicine at Freiberg, has died at the age of eighty-five years.

SIR ANTHONY HOME, late surgeon-general in the British army, died on August 9, aged eighty-seven years.

PLANS have been made for the founding of an Australian Institute of Engineers.

NEXT year's conference of the British Pharmaceutical Society is to be held at Scarborough under the presidency of Mr. Saville Peck.

THE International Seismological Congress, which was to have been held at St. Petersburg, has been postponed, as has also the Meteorological Conference, which was to have taken place in Edinburgh in September.

DR. KARL BENSINGER, of Mannheim, has given 30,000 marks to the University of Freiburg for the investigation of wireless telegraphy.

THE Prussian Academy of Sciences has offered a prize of 5,000 marks for the best study of "Experience as a Factor in Perception." The articles may be in German, Latin, French, English or Italian and must reach the academy by December 31, 1916.

A SPECIAL despatch from Philadelphia furnished by the American Osteopathic Association, begins with the remarkable statement: "Announcement was made here to-day at the International Osteopathic convention that

osteopathy has been discovered to be a cure for all acute infectious diseases."

It is stated in *Nature* that at least two English expeditions to observe the total solar eclipse of August 2, reached their destinations and observed the eclipse under most favorable weather conditions. The two parties were the observers from the Royal Observatory, Greenwich, consisting of Messrs. Jones and Davidson, and the expedition sent out by the joint permanent eclipse committee of the Royal and Royal Astronomical Societies, composed of Fathers Cortie and O'Connor and Messrs. Atkinson and Gibbs. The Greenwich party, stationed at Minsk (Russia), observed the eclipse under good conditions in a clear sky, and photographs of both the corona and chromosphere were secured. It is stated that the form of the corona was of the intermediate type, *i. e.,* of the square type, there being no larger equatorial streamers or streamers in the regions of the solar poles. The corona is also stated to have been very bright. The party under Father Cortie, S.J., took up their position at Hernoesand in Sweden, and his telegram to the Royal Astronomical Society says, "Weather perfect. All operations successful. Intermediate corona."

There will be examinations on October 19 for admission to the grade of assistant surgeon in the United States Public Health Service. Candidates must be between 23 and 32 years of age, graduates of a reputable medical college, and of good moral standing. The examinations are: 1, physical; 2, oral; 3, written; 4 clinical. Successful candidates will be numbered according to their attainments on examination, and commissioned in the same order. Assistant surgeons receive $2,000; passed assistant surgeons, $2,400; surgeons, $3,000; senior surgeons, $3,500, and assistant surgeon generals, $4,000 a year. For invitation to appear before the board of examiners, application should be made to the "Surgeon General, Public Service, Washington, D. C."

A brief report by Edgar T. Wherry describing a deposit of carnotite near Mauch Chunk, Pa., is published as Bulletin 580-H of the United States Geological Survey. Carnotite is one of the radium-bearing metals and this deposit is believed to have been formed by precipitation from the ground water and can now be seen in process of formation where water trickles out through cracks in the rocks. The deposit is of interest, but the present knowledge regarding it is insufficient to warrant any statement as to its workability. So far as is now known the total area covered by the carnotite-bearing lenses is very small, the observed outcrops being confined to a strip but a few hundred feet in extent.

The Berlin correspondent of the *Journal* of the American Medical Association reports that more than a year ago, under German initiative, an international health office was established in Jerusalem under the direction of Mühlens, the scientific assistant in the Hamburg Institute for Marine and Tropical Diseases. According to a recently published article of Nocht, director of the Institute for Marine and Tropical Diseases, the support of the institute at Jerusalem at present is shared in common by the German Committee for the Campaign against Malaria in Jerusalem; by Nathan Strauss of New York, and by the Society of Jewish Physicians and Scientists for Sanitary Interests in Palestine. The German committee supports the general department for combating malaria, and its chairman is at the same time the director of the institute. Nathan Strauss supports the hygienic and bacteriologic department of which the heads are Drs. Brünn and Goldberg. The Society of Jewish Physicians and Scientists has taken over the department for protection against rabies, originated by a German committee, the director of which is Dr. Behan. An accessory department for the prevention of eye diseases (director, Dr. Feigenbaum) has been added.

The British War Office has issued to officers of the royal army medical corps the following memorandum on antityphoid inoculations:

1. There is no need to remind officers of the Royal Army Medical Corps of the disastrous effects of typhoid in recent campaigns.

2. It can hardly be hoped that improved

sanitary precautions will succeed completely in safeguarding the force from infection, since it will certainly be exposed to three sources of infection, difficult or impossible to control, namely: (*a*) Men in the incubation stage of typhoid who have accompanied or joined the force. (*b*) Unsuspected typhoid carriers. (*c*) Contact with the inhabitants of the country in which typhoid may be present.

3. The preventive value of antityphoid inoculation is now universally recognized, and is well known to all who have served in India.

4. As it was not found possible to inoculate the force on mobilization, only a small percentage of the men will have been protected, but it should be practicable, by seizing every opportunity, to raise the number of inoculated very considerably. If a unit is likely to be stationary for a short time, advantage might be taken of this with the consent of the general staff, to inoculate a certain number of men,—for example, a company or half a company, and in this way a whole regiment or other unit might be protected, without any serious interference with its duties. In the same way individual men temporarily disabled by minor ailments, or otherwise available, might be inoculated. It is strongly urged that medical officers lose no opportunity of introducing and carrying through some such system.

5. Antityphoid vaccine has been sent to the base depot of medical stores, and will be issued, as required, on requisition.

The value of the output of recoverable gold, silver, copper, lead and zinc from mines in California in 1913, according to Charles G. Yale, of the United States Geological Survey, was $26,812,489, an increase of $428,543 over the 1912 production. All the metals except zinc showed an increased yield, although the ore treated was less in quantity and there were fewer mines reporting a production than in 1912. The total recoverable value of gold from California in 1913 was $20,406,958, of which the deep mines produced $11,570,781, or 56.7 per cent. The total increase in the gold production was $693,480, of which $502,966 was in the yield from deep mines. The gold production was larger than in any other year except one since 1864. This great output was due entirely to the operations of the dredging companies and the larger deep mines, as the number of mines operated in 1913 was 245 less than in 1912. Of the gold recovered from placer mines the gold dredges reported $8,090,294, which was nearly 92 per cent. of the placer gold mined and nearly 40 per cent. of the total state yield in 1913. Since the commencement of gold dredging in California, 15 years ago, the gold recovered from this source has amounted to $63,505,485. Most of this large yield has been derived from ground which could not have been mined profitably under any of the old methods of gravel mining. The 410 deep mines sold or treated 2,495,958 tons of ore, a decrease of 145,539 tons, compared with 1912. Most of the siliceous ore, which amounted to 2,031,429 tons, was treated at gold and silver mills, yielding an average recovery of $5.61 a ton in gold and silver. The 448,439 tons of copper had a recoverable value of $1.84 a ton in gold and silver and $11.74 in copper. The 14,267 tons of lead ore treated had a recoverable value of $11.24 in gold and silver and of $23.11 for all metals. The zinc ore shipped in 1913 amounted to 1,823 tons, which was considerably less than in 1912. The recoverable silver in 1913 amounted to 1,378,399 fine ounces, valued at $832,553, an increase of 78,263 fine ounces in quantity and of $32,969 in value. The copper ores from Shasta county contained about 60 per cent. of the 1913 production of silver from California.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. William J. Young has given $25,000 to the Medical Department of the University of Georgia for the improvement of its library.

The Company of Drapers of the City of London has made a grant of £500 a year for three years in aid of the work of the Department of Applied Statistics at University College, London, including the Galton Laboratory of Eugenics and the Drapers' Biometric Laboratory.

Dr. Frederick A. Saunders has resigned the professorship of physics in Syracuse Univer-

sity to accept the corresponding position in Vassar College.

DR. LAWRENCE E. GRIFFIN has been appointed professor of zoology in the University of Pittsburgh.

DR. ROBERT M. OGDEN, of the University of Tennessee, secretary of the American Psychological Association, has accepted the chair of psychology at the University of Kansas.

DR. FRIEND E. CLARK has resigned his position as professor of chemistry in Center College, Danville, Ky., to become professor of chemistry in West Virginia University.

SAMUEL W. GEISER, B.S. (Upper Iowa, '12), has been appointed professor of biology at Guilford College, North Carolina.

DEAN A. WORCESTER, B.A. (Colorado, '11), has been appointed associate professor of psychology in the University of New Mexico.

DR. HAROLD CHAPMAN BROWN, of Columbia University, has been appointed assistant professor of philosophy in Stanford University.

IRENE HUNT DAVIS, instructor in chemistry at the University of Washington, has been promoted to be assistant professor of chemistry.

THE following have been recently appointed to positions in George Peabody College for Teachers: Mr. Charles C. Colby, from the Minnesota State Normal School, as associate professor of geography; Miss Ada M. Field from Teachers College; Miss Blanche Evelyn Hyde from Newton, Mass., as assistant professors of home economics; Dr. William F. Russell, honorary fellow in Teachers College, as associate professor of secondary education. Dr. Leonidas C. Glenn, professor of geology, and Dr. John J. Luck, assistant professor of mathematics, of Vanderbilt University, have been secured to give special courses at the college.

DR. THEODORE SHENNAN, at present pathologist to the Royal Infirmary of Edinburgh, has been appointed regius professor of pathology (Sir Erasmus Wilson Chair) in the University of Aberdeen, in the place of the late Professor George Dean.

DISCUSSION AND CORRESPONDENCE

DO AZOTOBACTER NITRIFY?

UNDER the caption of "Fixation of Atmospheric Nitrogen" Mr. Dan. H. Jones, in the *Transactions* of the Royal Society of Canada, Third Series, 1913, Vol. III., Sect. IV.,[1] gives the results of certain experiments tending to show that the azotobacter form nitrates in their body tissues. He states:

> Cultures of each variety in Ashby's solution when one month old gave the nitrate reaction with phenolsulphonic acid colorimetric test. As the cultures get older, up to several months, the reaction to the test gets slightly stronger. This nitrate is retained almost altogether in the bodies of the organisms. Cultures filtered through Berkefeld filter gave only a trace of nitrate in the filtrate and a strong reaction in the mass of organisms which did not pass through the filter. The filtrate plated out showed that some of the organisms had passed through the filter. But as it took about ten days to filter enough for a test it is possible that the organisms had grown through the filter in that time. Probably the presence of a small number of organisms in the filtrate was responsible for the trace of nitrate in the tests. Mass growths on Ashby's agar, when mature, gave a strong nitrate reaction.

The author does not state to what extent pigmentation had taken place, but as the material experimented with represented old cultures it is probable that a considerable degree of pigmentation was present. He says:

> As the cultures get older, up to several months, the reaction to the test gets slightly stronger.

The present writer was deeply interested in this subject in connection with work which he was doing in 1910 and 1911 and stated in describing some samples of soil used in studying the subject of fixation,[2] that

> a certain sample gave, at the beginning of the experiment, an unsatisfactory growth of azotobacter but thirteen days later another culture made from the same sample gave a heavy membrane in four days on which brown points developed on the eighth or ninth day.

Again on page 93 of the same bulletin it is stated:

[1] The title of the article is "A Morphological and Cultural Study of Some Ozotobacter."

[2] Bull. 178, p. 87, Colo. Expt. Sta., 1911.

The question of whether the azotobacter both fix the atmospheric nitrogen and convert it into nitric acid, respectively nitrates, or whether this latter work is done wholly by another genus or other genera of bacteria is, perhaps, a question to be settled, but, be it settled as it may . . . we have instances of the accumulation of very large quantities of nitrates in our soils always associated with the brown color which we know to be caused by the azotobacter. I believe, and this belief is based upon tentative facts, that the azotobacter are at the same time nitrifiers, *i. e.*, that they possess a double function, which, I believe, has already been asserted, but not generally accepted.

This subject has not been referred to in later bulletins because I believe that my tentative facts were interpreted wrongly.

The tentative facts referred to were, in the first place, that with pure cultures made on sand I obtained a decided color reaction with phenolsulfonic acid which might readily be taken for the reaction due to nitric acid, in the second place, the power of pigmentation in successive cultures of azotobacter weakens and finally disappears. The loss of this power of pigmentation is not permanent, for, as Professor Sackett has since shown, the addition of a very small amount of a nitrate to the culture medium restores it.

I interpreted the former fact, the reaction with phenolsulfonic acid, as rather strong proof of the presence of nitric acid and the latter fact as supporting this view. It seemed to me that the second fact given, *i. e.*, the weakening of the power of pigmentation, pointed to an ability of the azotobacter to nitrify in a limited measure and that this function was lessened in the succeeding generations grown on mannite-agar until it finally vanished while the purely vegetative function was retained apparently unimpaired. With these facts and views in mind I wrote the sentences quoted from Bull. 178 of this station but I was very far from being satisfied with the tentative facts. At my request Professor Sackett kindly made other cultures from two of his stock cultures which had shown marked ability to form pigments. These cultures were made on a much larger scale than those previously made on sand and were allowed to incubate till the pigments were well developed. The membranes were removed from the agar and the agar washed with distilled water. The wash water was rendered alkaline by the addition of sodic carbonate and evaporated to dryness. The membrane that had been removed was added to the residue and the whole was thoroughly mixed and dried. A portion of the dried mass was tested with phenolsulfonic acid and yielded a deep brown solution which, on sufficient dilution, gave a yellow color with a tinge of brown. A most excellent imitation of those unsatisfactory solutions sometimes obtained on applying this test to samples of soils. We tried such means as were at our command to remove the brown color or tinge which does not belong to the nitric acid reaction but without success. We rejected this phenolsulfonic acid test because the results were so doubtful that we considered them valueless in this particular case.

A larger portion, in fact all that we had left of the dried membrane, was treated with ferrous chlorid and hydrochloric acid with all of the precautions demanded by this method. The volume of gas evolved was only 2.3 c.c. which was transferred to an absorption burette and a freshly boiled, concentrated ferrous chlorid solution allowed to flow into the gas. No absorption took place and no brown color was produced on the margins of the slowly inflowing stream of ferrous chlorid solution which constitutes an exceedingly delicate test for nitric acid. These results indicated that our previous caution was fully justified and that the color obtained with phenolsulfonic acid was due, not to nitrates but to the action of the reagents upon the substances in the membrane itself, most probably upon the pigments.

We may add apropos to these pigments that while they are difficultly soluble or insoluble in the menstrua usually used, pure water, alcohol, etc., the presence of various salts in aqueous solution cause them to dissolve to a greater or less extent; one, which, in some cases, is sufficient to impart a yellowish-brown color to the solution. We have often met with this in ma-

king aqueous extracts of our brown soils. The phenolsulfonic acid test for nitric acid is not applicable to such soils due to the interference of these pigment reactions. We were not satisfied with the results obtained in the experiments already given so we repeated them on a still larger scale, but with the same results which we consider as positively establishing the fact that the azotobacter do not nitrify but that the pigments which they form may give with phenolsulfonic acid, especially in very dilute solutions, a color reaction deceptively similar to that given by nitric acid and this reagent. WM. P. HEADDEN

COLORADO EXPERIMENT STATION,
FT. COLLINS, COLO.

NORTHERN LIGHTS IN SUMMER

I live at Nett Lake, Minnesota, 140 miles northwest of Duluth and 38 miles south of Fort Frances, Ontario, Canada. On the night of July 4 there was a fine display of northern lights (aurora borealis). It was as fine a display as is seen in this section even in the coldest months. There were spires and rolls of light and a bow of light which covered the whole northern sky and towards midnight reached nearly to the zenith.

ALBERT B. REAGAN

NETT LAKE, MINN.,
July 6, 1914

SCIENTIFIC BOOKS

The Cambridge Manuals of Science and Literature. Edited by P. GILES and A. C. SEWARD. New York, G. P. Putnam's Sons.

A review of the Cambridge Manuals appeared in SCIENCE of April 18, 1913; but since that date numerous additional volumes have come to hand, dealing with the most diverse topics. I give a list, with a few comments.

The Flea. By HAROLD RUSSELL.

When, some years ago, a member of the wealthy house of Rothschild took to collecting and describing fleas, there was a tendency to regard the circumstance in a humorous light, and perhaps even to enquire whether a man, to whom so many doors of opportunity were open, could not find something better to do. To-day, the connection between fleas and the plague having been established, Rothschild finds himself the greatest living authority on a subject of the highest importance to medical men, and no well-informed person has anything but praise for his work. The oriental rat-flea, the one mainly concerned in the spread of bubonic plague, was first made known to science by Rothschild, and the development of psyllology is illustrated by the collection of about a hundred thousand specimens at Tring.

Mr. Russell has had the advice of Mr. Charles Rothschild, and we may assume that his readable little book is up-to-date. It should be in the hands of medical men and the public generally, especially in regions where fleas are abundant. We would venture to suggest that if another edition appears the exceedingly crude text-figures should be replaced by better ones; that on page 81, in particular, is really scandalous.

Bees and Wasps. By O. H. LATTER.

This also is illustrated by very rough figures, without much pretence to accuracy in detail. The point of view is strictly British, but as many genera are common to Europe and America, the descriptions are more or less applicable to our species. The excellent accounts of the habits of English bees and wasps could scarcely at present be duplicated in this country, owing to the lack of observations. The work of the Peckhams on the solitary wasps, and that of various American observers on particular species of bees and wasps, is quite as good as anything done in Europe; but we still remain largely or wholly ignorant concerning the habits of many of our genera.

The Life Story of Insects. By G. H. CARPENTER.

This book is well illustrated, and the author has not hesitated to borrow many of his figures from American sources. The treatment of the subject is broad, and although the work has only 134 pages, Professor Carpenter manages to convey a great deal of information in an interesting way. This is, I think, the best brief introduction to entomology yet published.

Natural Sources of Energy. By A. H. Gibson.

Figure 7 is a map of the world showing "regions subject to intense solar heat and with slight annual rainfall," including under this description nearly all of the western United States, even the Rocky Mountains of Colorado to their summits, and the coast of Oregon. Figure 8 is a similar map showing "regions suited for the maintenance of vegetable and plant life" (why vegetable *and* plant?). "Luxuriant vegetation shown in black;" a moderate amount in gray, and a minimum in white. The *whole* of the western United States, except tongue extending from the north through Montana, is pure white! We commend this especially to Californians, who have been under the delusion that their country supported some vegetation. Fig. 11 shows, in black, the "principal water powers of the world," and includes, in a large black area, the Rocky Mountains of Colorado and northward. How does it happen that this intensely hot region, with very little rain, and consequently next to no vegetation, is one of the principal areas where water-power may be obtained?

Submerged Forests. By Clement Reid.

Based on the brilliant original researches of the author, extending over many years, this discussion of the submerged forests on the coasts of the British Islands is equally fascinating to the botanist, geologist and anthropologist. It deals almost entirely with British work and phenomena, and has little to say about the labors of the Scandinavians and others in different parts of Europe. Thus, regarded as a general presentation of the matter, it seems narrow; but we can well forgive this in our appreciation of the intimate knowledge which the author has of his field, permitting him to speak with more assurance than would have been possible had he discussed the submerged forests of all Europe. For us in America the work carries many suggestions; thus we are surprised at the number of recognizable seeds obtainable from old peat deposits, permitting us to gain a fairly accurate knowledge of the herbaceous as well as woody flora of ancient times.

The Beautiful. By Vernon Lee.

An original treatment of the subject from a psychological point of view. This is, perhaps, a place where Bergson's contention that the intellect is not able to understand life strikes one with special force; but the author has no such misgivings, and proceeds to a logical and detailed analysis.

The Evolution of New Japan. By J. H. Longford.

The interpretation of Japan is so difficult for an occidental that all books of this sort fall under suspicion; but Professor Longford was British Consul at Nagasaki, is now professor of Japanese in King's College, London, and is well known as a writer of works on Japan, so he has certainly won the right to be heard. The reviewer, having no critical knowledge of the subject whatever, read the little book with great pleasure, and can at least testify that it presents an exceedingly lucid account of the whole matter as the author understands it. There is here and there some evident inconsistency. Thus on page 3 we read, without qualification, that "the first emperor was Jimmu Tenno, who founded the Empire and ascended the throne in the year 660 B.C."; but on pages 17 and 143 we learn that this Jimmu is a pure myth. On page 81, the British government of 1894 receives severe censure for "sacrificing" the interests of British residents in Japan, but on page 84 we learn that as the result of the treaty thus condemned, trade "more than doubled in its volume," and the anticipated bad results did not occur.

The Wanderings of Animals. By H. Gadow.

Pearls. By W. J. Dakin.

The Earth. By J. H. Poynting.

The Fertility of the Soil. By E. J. Russell.

The Atmosphere. By A. J. Berry.

The Story of a Loaf of Bread. By T. B. Wood.

The Physical Basis of Music. By A. Wood.

The Peoples of India. By J. D. Anderson.

The Modern Warship. By E. L. Attwood.

Naval Warfare. By J. R. Thursfield.

The Icelandic Sagas. By W. A. Craigie.

A Grammar of English Heraldry. By W. H. ST. JOHN HOPE.

One great merit of these books is that they frequently call attention to neglected subjects, or cut familiar subjects at unfamiliar angles. Thus they should be instrumental in releasing us from the tyranny of the conventional text-book. We ought to have a similar series in America, dealing with subjects of special interest to us, and using American examples in illustration.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

The American College: What it is and What it may Become. By CHARLES F. THWING. New York, Platt & Peck Co. 1914.

President Thwing's "The American College" is a handsome book of 294 pages. Perhaps because the author had already published sixteen volumes in the same general field, the seventeenth gives the reader the impression of being thin in some spots and padded in others. The author must have either an extraordinary memory or an excellent bibliographical card index on academic subjects. At any rate, the quotations scattered through his book, if a little too numerous, are unhackneyed and interesting. His academic experience has been great and his sympathies are keen. There is little or nothing in the book with which one would disagree, and some of the sections are particularly good, as, for example, the discussion of woman's education and the frank confession of our present ignorance as to the differences between men's minds and women's. The book, as a whole, however, suffers from a lack of definite "attack" on the part of the author. It seems addressed to nobody in particular—or rather to different people at different times, students, parents, trustees, millionaires.

Possibly these matters have been discussed in some of the other books by the president of Western Reserve University, but so far as the present volume is concerned there is no mention of what seems to the reviewer to be really the most significant thing to-day—the rapid differentiation throughout the United States of the colleges that mean business from those that do not. There seems to be insufficient emphasis, also, on the need of developing a sense of individual responsibility on the part of the student, and on that most acute problem which faces every live college, that of distributing the new wine of the present vintage of thought with as little damage as possible to the bottles provided by the previous generation.

F. P. KEPPEL

SCIENTIFIC JOURNALS AND ARTICLES

THE contents of the September *Terrestrial Magnetism and Atmospheric Electricity* are as follows: "The Local Magnetic Constant and Its Variations," by L. A. Bauer; "Magnetic Declinations and Chart Corrections Observed on the *Carnegie* from Long Island Sound to Hammerfest, Norway, June to July, 1913," by L. A. Bauer and J. P. Ault; "The Atmospheric-Electric Observations made on the Second Cruise of the *Carnegie*," by O. W. Hewlett; "On Certain New Atmospheric-Electric Instruments and Methods," by W. F. G. Swann; Letters to Editor, Notes and Recent Publications.

SPECIAL ARTICLES

THE MEASUREMENT OF CHANGES IN THE RATE OF FECUNDITY OF THE INDIVIDUAL FOWL [1]

1. THE purpose of this preliminary note is to call attention to a method of measuring and representing graphically changes in the intensity of ovarian activity, as indicated by rate of ovulation in the domestic fowl. It has been fully established[2] that if one considers the egg production records from a group or flock of hens as a whole there are observable regular and distinct cycles in the production. Thus, we have distinguished in former publications between winter, spring and summer cycles of flock production. It has not hitherto been possible to observe precisely or to measure any such cyclical changes (either

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 70.

[2] *Cf.* Pearl, R., and Surface, F. M., "A Biometrical Egg Production in the Domestic Fowl." II. Seasonal Distribution of Egg Production. U. S. Dept. Agr. Bur. Anim. Ind. Bulletin 110, Part II., pp. 81–170, 1911.

of long or short period) in the egg production of a single individual bird, owing to the fact that the production is in discrete units. Yet while the end products of ovarian activity are discrete units there are very strong reasons for supposing that physiologically the elaboration—or production in the broad sense—of eggs by the ovary is a continuous process. This matter has been rather fully discussed in a former paper from this laboratory.[3] Evidence of another sort for the continuity (in the mathematical sense) of ovarian activity has recently been given by Gerhartz[4] in a valuable paper on metabolism in the fowl.

2. By a simple statistical expedient it is possible to represent the changes in rate of fecundity in an individual bird as a continuous curve, of which the ordinates represent the rates of egg production on a percentage scale (0 to 100) at the time intervals plotted as abscissæ. This is done by taking, as the rate of fecundity for any given day p_n, the percentage which the actual number of eggs laid by the bird during the 21 days of which p_n is the central day, is of 21. Put as a formula, if

Rp_n = rate of fecundity (or ovarian activity as indicated by ovulation) on the day p_n,

1 = an egg produced,

and Σ denotes summation between the indicated limits, we have

$$R_{p_n} = \frac{100\,(\sum_{p_n-10}^{p_n+10} 1)}{21}.$$

The rates so calculated for each successive day may be plotted as a curve.

3. The reasons why 21 days are chosen as the basis of the calculation rather than some other odd number of days will be fully discussed in the complete paper. Here it need only be said that there are good biological grounds for this choice. Gerhartz[5] has shown, for example, that this number represents about the average number of oocytes to which any appreciable addition of yolk is being made at any given instant of time.

4. Applying this method to records of one, two and three year old hens many interesting and novel points regarding ovarian activity, as expressed in ovulation, may be made out. The long period secular cycles of production appear much more clearly and precisely than in flock mass statistics. The steady diminution in maximum rate of fecundity per unit of time after the first spring cycle in the bird's life is very strikingly shown in the great majority of cases.

This method of measuring fecundity opens the way to the attacking *in the individual* of a number of problems which hitherto have only been amenable to indirect, statistical treatment. Such, for example, are the questions of relation of size of egg to rate of fecundity, the relation between fertility (in the fowl readily measured by hatching quality of eggs) and fecundity. There are many other interesting biological problems relating to reproduction in birds, the analysis of which will certainly be aided by the method here discussed.

The complete paper describing the method and illustrating it fully by examples will shortly be published elsewhere.

Raymond Pearl

[3] *Cf.* Pearl and Surface, *loc. cit.*

[4] Gerhartz, H., "Ueber die zum Aufbau der Eizelle notwendige Energie (Transformationsenergie)," *Pflüger's Arch.*, Bd. 156, pp. 1–224, 1914.

[5] *Loc. cit.*

THE NORTH CAROLINA ACADEMY OF SCIENCE

The North Carolina Academy of Science met in its thirteenth annual session at Trinity College, Durham, on Friday and Saturday, May 1 and 2, 1914, with 28 members in attendance. The executive committee held a meeting in the early afternoon of Friday, and this was followed by a general meeting for the reading of papers. At night, after Dean W. I. Cranford had welcomed the academy to Trinity College, President Franklin Sherman, Jr., of the academy, read his presidential address, "The Animal Life of North Carolina with some Suggestion for a Biological Survey." Following this, Professor A. H. Patterson gave a lecture on "The Gyroscope and its Modern Applications" with demonstrations of some fine apparatus. Next Mr. Bert Cunningham gave a striking demonstration of the new nitrogen tungsten lamp, comparing its light efficiency with that of

ordinary tungsten and carbon lamps consuming the same amount of current. At the conclusion of the session the faculty of Trinity College gave a smoker complimentary to the members of the academy.

The annual business meeting was held at 9 A.M. on Saturday, May 2. Reports of the executive and other committees and of the secretary-treasurer were read. An invitation for the academy to meet at Wake Forest College in 1915 was accepted. A committee was appointed to formulate and present recommendations to the next legislature for a statute regulating the ventilation of public buildings in the state. A resolution was passed endorsing President Sherman's suggestions concerning a biological survey of the state. Four new members were elected. These with present enrollment of 64 give a total of 68 members.

The following officers were elected for the ensuing year:

President—J. J. Wolfe, Trinity College, Durham.

Vice-president—A. H. Patterson, University of North Carolina, Chapel Hill.

Secretary-Treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional Members Executive Committee—W. N. Hutt, State Department of Agriculture, Raleigh; J. H. Pratt, State Geological Survey, Chapel Hill; W. A. Withers, North Carolina Agricultural Experiment Station, West Raleigh.

At 9:45 the reading of papers was resumed and continued until 12:30 when the program was finished. The total attendance was 30 out of a membership of 68. The number of papers on the program was 30, of which only two were read by title. Marked features of the meeting were the considerable number of papers read and the discussions participated in by a large number of those present. Including the presidential address, which was published in full in the May number of the *Journal of the Elisha Mitchell Scientific Society*, the following papers were presented:

Presidential address—Studies of the Animal Life of North Carolina with Suggestions for a Biological Survey: F. SHERMAN, JR.

The first questions asked when any animal or plant arouses interest have to do with its identity, distribution, seasonal activities and economic relations, hence the need of biologists supplying this information in some form available for reference. Very little accurate information on these points can be obtained from the public itself, it must be threshed out by careful work on the part of the biologists. Many cases can be cited showing that forms formerly believed to be harmless are really important, as shown by discoveries in medical entomology, hence our studies should include all forms of life. Such studies should not only include the listing of species, but also the mapping out of their distribution, and the seasons of their occurrence and activities.

In this work in North Carolina, considerable progress has been made in the study of the larger marine invertebrates, chiefly at the government Biological Laboratory at Beaufort. Land invertebrates exclusive of insects have been little studied. In the insects, considerable progress has been made in many groups, especially the order Orthoptera, parts of the order Hemiptera, dragon-flies in the Neuroptera, butterflies and larger moths in the Lepidoptera, several families in the Diptera, a large number of records in Coleoptera though only a good start, and very little in the Hymenoptera.

In the vertebrates, the fish fauna is already well presented in "Fishes of North Carolina," much data has been accumulated regarding the batrachians and reptiles, a volume on the birds is now in course of preparation, and the mammals, on the whole, are fairly well known.

What has thus far been accomplished, has been largely out of fondness for the subject, and quite incidental to other duties, the data has been gathered from publications and specimens collected by many persons both within the state and from outside, and it is hoped that the biologists in the state will attempt to complete, compile and publish these records in appropriate volumes until the fauna of the state shall be definitely placed on record. Botanists are urged to undertake the same for the flora.

Such studies would supplement and strengthen the work of morphologists, and would aid the study of such directly economic problems as the life-histories of insects, spread of weeds and fungous diseases, efficiency of birds in control of pests, etc.

Economic Geology of Chapel Hill, N. C. and Vicinity: JOHN E. SMITH.

GENERALIZED SECTION OF MANTLE ROCK

	Thickness, Ft.
1. Soil, "top soil," red to gray or black...	1 to 3
2. Subsoil, fine, somewhat compact, red to yellow clay	3 to 10

3. Clay, coarse and lumpy, with some sand. 5 to 20
4. "Natural sand-clay," feldspar, quartz, sand and clay ....10 to 20
5. Fragmental rock, angular, decayed, size 2 to 4 in. ....10 to 20
6. Fragmental rock, coarser and fresher than that in 5 .... 5 to 15
7. Granite, "bed rock," "country rock."

This region serves as a type for Piedmont areas in which granite is the underlying rock—about one third of the Piedmont Belt.

Zone No. 1 is the surface soil of the upland and is used in agriculture and in road building. No. 2 provides clay suitable for brick and tile. As the topography is mature and these zones have been removed by erosion from much of the area, the value of the land is low. The material of zone 4 makes good sand-clay roads. This is approximately horizontal and outcrops on the slopes where valleys have been cut below its depth. Stream sand is used in making mortar and in road construction.

This mantle rock forms an excellent filter and most wells in it are free from contamination. Excepting the mountain region, these are the most healthful areas in the south.

An Achlya of Hybrid Origin: W. C. Coker.

An *Achlya* was described from Chapel Hill, N. C., with peculiarities that suggest a hybrid origin. The tips of the hyphae often die and the growth is then extended as a side branch below the dead tip. The spores show a strong tendency to poor organization, the protoplasm often segregating only imperfectly, and producing irregular masses of various sizes. The same is true of the eggs, which are of any size and almost never become perfectly organized, and die quickly. The plant seems most like *Achlya polyandra* Hildeband, but differs from it in the walls of the oogonia being pitted and in the abnormal behavior of the eggs.

It is suggested that the plant may be a hybrid between *A. DeBaryana* Humphrey and *A. apiculata* DeBary.

The Nurse Sharks of Boca Grande Cay, Florida: E. W. Gudger.

Boca Grande Cay is an island of coral sand and mangroves lying about 20 miles west of Key West. Situated on a shallow submarine platform, about 120° of its circumference is surrounded by sand flats inhabited largely by sting rays. Another 120° of its circumference is bounded by a shallow, gently sloping, rock bottom on which the water a half mile from shore will not be over a man's shoulders. On this rocky bottom, the nurse sharks, *Ginglymostoma cirratum,* come out to bask in the sun, to play, to breed, and possibly to feed. Here they are found in large numbers. A dozen can be seen at almost any time, and thirty-three have been counted in the sweep of the eye.

These sharks in looks and habits much remind one of well-fed pigs in a barnyard. They are much broader in the pectoral region than ordinary sharks, are sluggish in their movements, and are comparatively unafraid of man. They frequently lie in water so shallow that their dorsals project above the surface, and a number of times they allowed the boat to drift down over them and strike their fins before they would move.

They lie with heads on each others pectorals or tails, or one will have his snout elevated on another's flank, or they will lie heads and tails together or in a confused herd. Here again this similarity of habits to barnyard pigs is very noticeable. Further they often swim one after another to the number of three or four in an aimless fashion, each one following the purposeless turnings of its leader.

They are perfectly harmless. Their mouths are small and filled with small pointed teeth. They are omnivorous in feeding like most sharks, but their food seems chiefly to be crustacean, probably consisting of the large spiny "crawfish" common on the reef and on rocky bottom of any kind.

Under the circumstances noted above, there is, of course, no difficulty in killing these sharks. Ordinarily shark fishing is good sport, but killing nurse sharks is no more exciting than sticking pigs in a barnyard. Indeed the Key West fishermen contemptuously speak of them as "Nurses," and of the other sharks as "sharks."

Work on the habits and embryology of this shark is being carried on under the auspices of the Marine Laboratory of the Carnegie Institution of Washington situated at Tortugas and will be continued this summer.

Flowers and Seed Development of Specularia perfoliata: H. R. Totten and J. A. McKay.

There are two kinds of flowers, conspicuous open ones with normal corollas and small bud-like flowers that never open. The last or cleistogamic flowers were described carefully by von Mohl, as long ago as 1863.

It is the object of this paper to give the development of the seeds in the cleistogamic flowers. The seeds are of the same size and appearance as those borne in the open flowers. Four megaspores are

formed and the embryo-sac develops from the lower one. It is surrounded by a single nucellar layer and one thick integument. The endosperm nucleus forms a cellular endosperm from the first division. The young endosperm sends out a knob-like haustorium of one or two cells at each end. The suspensor of the embryo grows up into the micropylar haustorium, to some extent, forming a small enlarged knob there. As the seed grows the haustoria are encroached upon and destroyed.

Studies in the Toxicity of Cottonseed Meal: W. A. WITHERS, R. S. CURTIS AND G. A. ROBERTS.

About one hundred and seventy-five hogs were fed upon cottonseed meal or some fraction of it. The swine died in every case after eating the meal for periods ranging on average from 59 to 96 days. Twenty-two rabbits fed on cottonseed meal died on average of 13 days.

With different solvents used, the extract was usually non-toxic and the residue usually toxic.

Green feed, liberal exercise and ashes seemed to be of some aid to pigs in overcoming the toxic effect of cottonseed meal. Treatment of the meal with an alcoholic alkali rendered the meal non-toxic to rabbits.

Citrate of iron and ammonia was effective with rabbits and ferrous sulphate was effective with swine as an antidote to the toxicity of cottonseed meal.

The Locust Tree Carpenter Moth, a Formidable Parasite of the Oak: J. J. WOLFE.

In February, 1911, a white oak about fourteen inches in diameter, on the campus of Trinity College was seen to be severely injured as a result of the boring habits of what proved to be the larvæ of *Pryonoxystus robiniæ*, commonly known as the locust tree carpenter moth. The tree was cut and sections of the trunk split into two pieces. Numerous winding tunnels were found throughout the heart and sap wood of the trunk and larger limbs. From these were collected fourteen larvæ of three distinct sizes—a fact supporting the view that the insect requires three years for its development. A portion of the trunk near the ground was riddled with holes—points of exit—in which wood-destroying fungi had established themselves and threatened the destruction of the tree.

The insect attacks several trees of the street, park and forest. Its habits render it a formidable pest. Means for its control on any large scale are at present wanting, but sporadic occurrences in trees of streets and parks might possibly be held in check by injecting into these tunnels a volatile poison and then plugging them with some waxy substance.

The Pecan Twig Girdler: C. L. METCALF.

A detailed account of the egg-laying habits of *Oncideres cingulata* Say; the preliminary and supplementary maneuvers habitually performed (which result in the severing of numerous twigs from the tree in which the eggs are laid); with a brief account of the life-history, economic importance and methods of control of the pest in commercial pecan orchards.

Some Rare Plants and Singular Distributions in North Carolina: W. C. COKER.

Announcement was made of the addition of a new tree to the flora of North Carolina. The pin oak (*Quercus palustris* DuRoi) was found near Chapel Hill by Mr. J. S. Holmes, state forester, in the fall of 1913.

Rhododendron catawbiense Michx., supposed to be confined in this state to the tops of the highest mountains, was reported as growing at Chapel Hill, Hillsboro, and other places in Orange county, and stranger still at Cary (near Raleigh), and even at Selma which is well into the coastal plain.

Venus' fly trap (*Dionæa muscipula* Ellis). Evidence as to distribution of this remarkable plant was reviewed and it was concluded that this species is distributed from Buckville, S. C., to New Bern, N. C., and westward along the Cape Fear River to Fayetteville.

The tuberous variety of tall meadow oat grass (*Arrhenatherum elatius* (L.) Beauv., var. *bulbosum*) was exhibited from Chapel Hill. This is a recent introduction from Europe where it is known as a troublesome weed. Within the last three years the U. S. Department of Agriculture has received it occasionally from Virginia to Georgia.

Blessed thistle (*Cnicus benedictus* L.) was shown to be a troublesome weed in Chapel Hill grain fields.

Euonymus atropurpureus Jacq. This is found to be one of the rarest shrubs in North Carolina, and known with certainty only from Chapel Hill.

The Lawn Problem in the South: W. C. COKER AND E. O. RANDOLPH.

This paper attempts to find some way of solving the hard problem of lawn-making in the South. Observations were made on many lawns, with various conditions of soil, exposure and care, to determine the grasses and weeds actually present. About six of the most promising grasses were carefully studied to determine their value and use as lawn cover.

Exhibits were made in trays of good sods formed by these six grasses, and also of some of the worst lawn weeds.

A Rough Method of Recording Seasonal Distribution: C. S. Brimley.

The method I am about to describe is not meant to take the place of full records or complete data with regard to any group of living things in which one is particularly interested, but rather to provide a convenient means of summarizing such records and also to record data concerning animals or plants in which one is less interested and therefore is not likely to take much trouble about.

The method is briefly this: rule the left-hand pages of a blank book into 12 vertical columns, leaving enough space on the left for the names of the species to be recorded, and leaving the right-hand page blank for any additional data. At the head of these twelve columns write the abbreviations, Jan., Feb., Mar., Apl., May, Jun., Jly., Aug., Sep., Oct., Nov., Dec., and when you have a record to make of a species, record it by the appropriate letter of the month in the column for that month, J standing for early January, a for middle January, n for late January and so on, early signifying from the first to 10th inclusive, middle for from 11th to 20th, late from 21st to end of month.

I have used this method very largely for recording the seasonal range of insects and give some examples below:

	Jan.	Feb.	Mar.	Apl.	May	Jun.	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.
Syrphids:												
Eristalis tenax		F.	Mar.	Apl.	May	Jun.	Jly.			Oct.	Nov.	Dec.
Eristalis transversa			r.	Apl.	May	Jun.	J y.		ep.	Oct.	Nov.	Dec.
Milesia ornata						Jun.	ly.	Aug.	e.	Oct.	N.	
Hawk Moths:												
Protoparce sexta						un.	Jly.	Aug.	Sep.			
Hemaris thysbe			r.	Apl.	M	un.	Jly.	Au.	e.			
Ceratomia undulosa				pl.	May	Jun.	Jly.					
Plant Bugs:												
Brochymena 4-pustulata	Jan.	Feb.	Mar.	Apl.	May	Jun.	Jly.		e.	Oct.	Nov.	Dec.
Murgantia histrionica ..			Mar.	Apl.	May	Jun.	Jly.	Aug.	Sep.	Oct.	Nov	
Euschistius servus	Jan.			Apl.	May	Jun.	Jly.	Aug.	Sep.	Oct.		
Euschistius tristigmus ..			Mar.	Apl.	May	Jun.	Jly.			Oct.	Nov.	

I have hundreds of species of insects recorded in this way and records are both easy of access and very serviceable when one wishes to find at what period of the year any particular insect is likely to occur. Of course separate records could be kept for each year and should of course be kept for different localities, but as a matter of course such a system would necessarily come into use mainly for the locality in which one spends the greater part of one's time.

E. W. Gudger,
Secretary

No abstracts have been received for the following papers:

"Movements of Plants," by J. D. Ives.

"A Report on Local Protozoa," by Z. P. Metcalf.

"By Raft and Portage: A Study in Early Transportation in North Carolina," by Collier Cobb.

"The Case of the Riparian Owner," by R. N. Wilson.

"Some Philippine Sponges," by H. V. Wilson.

"Economic Minerals in the Pegmatite Dikes of Western North Carolina," by J. H. Pratt.

"The Sclerotinia Disease of Clovers and Alfalfa," by H. R. Fulton.

"The Use of Home-made Models as an Aid in Teaching Embryology," by W. C. George.

"Electrical Conduction of Flowing Mercury," by V. L. Chrisler, presented by A. H. Patterson.

"Microscopic Demonstration of Protozoan Spores, Used as Proof of Contamination of Food with Human Excrement," by C. W. Stiles.

"Some Recent Developments in the Theory of X-rays," by C. W. Edwards.

"The Coggins Gold Mine," by J. H. Pratt.

"The Gyroscope and its Modern Applications" (with a demonstration), by A. H. Patterson.

"Geology in Relation to the Location of Highways in North Carolina," by Collier Cobb.

"The Corn Bill Bug," by Z. P. Metcalf.

"A Peculiar Case of Freezing," by R. N. Wilson.

"The Nitrogen Tungsten Lamp," by Bert Cunningham.

SCIENCE

FRIDAY, SEPTEMBER 25, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT TO THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

MAN AS A GEOGRAPHICAL AGENCY

IN an inaugural address to the Royal Scottish Geographical Society on Geography and Statecraft Lord Milner said: "If I have no right to call myself a geographer, I am at least a firm believer in the value of geographical studies." I wish to echo these words. I have no expert geographical knowledge, and am wholly unversed in science, but I am emboldened to try and say a few words because of my profound belief in the value of geographical studies. I believe in their value partly on general grounds, and largely because a study of the British empire leads an Englishman, whether born in England or in Australia, to the inevitable conclusion that statecraft in the past would have been better, if there had been more accurate knowledge of geography. This statement might be illustrated by various anecdotes, some true, not a few apocryphal; but anecdotes do not lend themselves to the advancement of science. I am encouraged, too, to speak because the field of geography is more open to the man in the street than are the sciences more strictly so-called. It is a *graphy,* not a *logy.* Geology is the science of the earth. Geography is a description of the face of the earth and of what is on or under it, a series of pictures with appropriate letterpress and with more or less appropriate morals to adorn the tale. The man in the street may talk affably and even intelligently about the face of the earth.

[1] Australia, 1914.

Taking the earth as it is, geographical discovery has well-nigh reached its limit. The truth, in the words of Addison's hymn, is now "spread from Pole to Pole," and recent exploration at the South Pole, with its tale of heroism, will have specially appealed to the citizens of this southern land. Coasts are in most cases accurately known. The age of Cook and Flinders is past. Interiors are more or less known. In Africa there is no more room for Livingstones, Spekes, Burtons and Stanleys. In Australia Sir John Forrest is an honored survival of the exploring age—the age of McDouall Stuart and other heroes of Australian discovery. The old map-makers, in Swift's well-known lines, "o'er unhabitable downs placed elephants for want of towns." Towns have now taken the place of elephants and of kangaroos. Much, no doubt, still remains to be done. The known will be made far better known; maps will be rectified; many great inland tracts in Australia and elsewhere will be, as they are now being, scientifically surveyed; corners of the earth only penetrated now will be swept and garnished. But as we stand to-day, broadly speaking, there are few more lands and seas to conquer. Discovery pure and simple is passing away.

But meanwhile there is one side of geography which is coming more and more to the front, bringing it more than ever within the scope of the British Association for the Advancement of Science. "Man is the ultimate term in the geographical problem," said Dr. Scott Keltie some years since at the meeting at Toronto. "Geography is a description of the earth as it is, in relation to man," said Sir Clements Markham, long President of the Royal Geographical Society. Geography, I venture to think, is becoming more and more a description of the earth as it is and as it will be under the working hand of man. It is becoming intensive rather than extensive. Geographers have to record, and will more and more have to record, how far man has changed and is changing the face of the earth, to try and predict how far he will change it in the coming centuries. The face of the earth has been unveiled by man. Will the earth save her face in the years before us, and, if she saves her face, will it be taken at face value? How far, for instance, will lines of latitude and longitude continue to have any practical meaning?

Man includes the ordinary man, the settler, the agriculturalist; man includes, too, the extraordinary—the scientific man, the inventor, the engineer. "Man," says a writer on the subject, "is truly a geographical agency," and I ask you to take account of this agency for a few minutes. I do so more especially because one of the chief features of the present day is the rise of the south; and the rise of the south—notably of Australia—is the direct result of human agency, on the one hand transforming the surface of the land, on the other, eliminating distance. The old name of Australia, as we all know, was New Holland. The name was well chosen in view of later history, for while no two parts of the world could be more unlike one another than the little corner of Europe known as Holland, or the Netherlands, and the great Southern Continent, in the one and in the other man has been preeminently a geographical agency.

The writer who used this phrase, "Man is a geographical agency," the American writer, Mr. G. P. Marsh, published his book, "Man and Nature," in 1864, and a new edition, entitled, "The Earth as Modified by Human Action," in 1874. He was mainly concerned with the destructiveness of man in the geographical and climatic changes which he has effected. "Every

plant, every animal," he writes, "is a geographical agency, man a destructive, vegetables and in some cases even wild beasts, restorative powers"; and again: "It is in general true that the intervention of man has hitherto seemed to ensure the final exhaustion, ruin and desolation of every province of nature which he has reduced to his dominion." The more civilized man has become, he tells us, the more he has destroyed. "Purely untutored humanity interferes comparatively little with the arrangements of nature, and the destructive agency of man becomes more and more energetic and unsparing as he advances in civilization." In short, in his opinion, "better fifty years of Cathay than a cycle of Europe."

He took this gloomy view mainly on account of the mischief done by cutting down forests. Man has wrought this destruction not only with his own hand, but through domesticated animals more destructive than wild beasts, sheep, goats, horned cattle, stunting or killing the young shoots of trees. Writing of Tunisia, Mr. Perkins, the principal of Roseworthy College, says: "In so far as young trees and shrubs are concerned, the passage of a flock of goats will do quite as much damage as a bush fire." Mr. Marsh seems to have met a fool in the forest, and it was man; and he found him to be more knave than fool, for man has been, in Mr. Marsh's view, the revolutionary radical confiscating nature's vested interests. "Man," he says, "has too long forgotten that the earth was given to him for usufruct alone, not for consumption, still less for profligate waste." Trees, to his mind, are conservatives of the best kind. They stand in the way, it is true, but they stop excesses, they moderate the climate, they give shelter against the wind, they store the water, prevent inundations, preserve and enrich the soil. "The clearing of the woods," he says, "has in some cases produced within two or three generations effects as blasting as those generally ascribed to geological convulsions, and has laid waste the face of the earth more hopelessly than if it had been buried by a current of lava or a shower of volcanic sand"; and, once more, where forests have been destroyed, he says, "The face of the earth is no longer a sponge but a dust-heap."

The damage done by cutting down trees, and thereby letting loose torrents which wash away the soil, is or was very marked in the south of France, in Dauphiné, Provence and the French Alps. With the felling of trees and the pasturing of sheep on the upper edge of the forest—for sheep break the soil and expose the roots—the higher ground has been laid bare. Rainstorms have in consequence swept off the soil, and the floods have devastated the valleys. The mountain-sides have become deserts, and the valleys have been turned into swamps. "When they destroyed the forest," wrote the great French geographer, Reclus, about thirty years ago, "they also destroyed the very ground on which it stood"; and then he continues: "The devastating action of the streams in the French Alps is a very curious phenomenon in the historical point of view, for it explains why so many of the districts of Syria, Greece, Asia Minor, Africa, and Spain have been forsaken by their inhabitants. The men have disappeared along with the trees; the axe of the woodman, no less than the sword of the conqueror, have put an end to, or transplanted, entire populations." In the latter part of the South African war Sir William Willcocks, skilled in irrigation in Egypt, and now reclaiming Mesopotamia, was brought to South Africa to report upon the possibilities of irrigation there, and in his report dated

November, 1901, he wrote as follows: "Seeing in Basutoland the effect of about thirty years of cultivation and more or less intense habitation convinced me of the fact that another country with steep slopes and thin depth of soil, like Palestine, has been almost completely denuded by hundreds of years of cultivation and intense habits. The Palestine which Joshua conquered and which the children of Israel inhabited was in all probability covered over great part of its area by sufficient earth to provide food for a population a hundred times as dense as that which can be supported to-day." The Scotch geologist, Hugh Miller, again attributed the formation of the Scotch mosses to the cutting down of timber by Roman soldiers. "What had been an overturned forest became in the course of years a deep morass."

In past times there have been voices raised in favor of the forests, but they have been voices crying in the desert which man has made. Here is one. The old chronicler Holinshed, who, lived in the reign of Queen Elizabeth, noted the amount of timber cut down for house building and in order to increase the area for pasturage. "Every small occasion in my time," he writes, "is enough to cut down a great wood"; and in another passage either he himself or one of his collaborators writes that he would wish to live to see four things reformed in England: "The want of discipline in the Church, the covetous dealing of most of our merchants in the preferment of commodities of other countries and hindrance of their own, the holding of fairs and markets upon the Sunday to be abolished and referred to the Wednesdays, and that every man in whatever part of the champaine soil enjoyeth forty acres of land and upwards after that rate, either by free deed, copyhold or fee farm, might plant one acre of wood or sow the same with oke mast, hazell, beach and sufficient provision be made that it be cherished and kept."

Mr. Marsh seems to have thought that the Old World, and especially the countries which formed the old Roman Empire, had been ruined almost past redemption; and for the beneficent action of man on nature he looked across the seas. "Australia and New Zealand," he writes, "are perhaps the countries from which we have a right to expect the fullest elucidation of these difficult and disputable problems. Here exist greater facilities and stronger motives for the careful study of the topics in question than have ever been found combined in any other theater of European colonization."

His book was first written half a century ago. He was a pessimist evidently, and pessimists exaggerate even more than optimists, for there is nothing more exhilarating and consoling to ourselves than to predict the worst possible consequences from our neighbor's folly. Further, though it may be true that man became more destructive as he became more civilized, it is also true that the destruction has been wrought directly rather by the unscientific than by the scientific man. If we have not grown less destructive since, at any rate we have shown some signs of penitence, and science has come to our aid in the work of reparation. Governments and associations have turned their attention to protecting woodland and reafforesting tracts which have been laid bare. The Touring Club of France, for instance, I am told, has taken up the question of the damage done by destruction of trees by men and sheep in Haute Savoie, and it assists reclamation by guidance and by grants. In England, under the auspices of Birmingham University and under the presidency of Sir Oliver Lodge, the Mid-

lands Reafforestation Association is planting the pit mounds and ash quarries of the Black Country with trees which will resist smoke and bad air, alders, willows, poplars, carrying out their work, a report says, under a combination of difficulties not to be found in any other country. Artificial lakes and reservoirs again, such as I shall refer to presently, are being made woodland centers. In most civilized countries nowadays living creatures are to some extent protected, tree planting is encouraged by arbor days, and reserves are formed for forests, for beasts and birds, the survivors of the wild fauna of the earth. Some lands, such as Greece, as I gather from Mr. Perkins's report, are still being denuded of trees, but as a general rule the human conscience is becoming more and more alive to the immorality and the impolicy of wasting the surface of the earth and what lives upon it, and is even beginning to take stock as to whether the minerals beneath the surface are inexhaustible. Therefore I ask you now to consider man as the lord of creation in the nobler sense of the phrase, as transforming geography, but more as a creative than as a destructive agency.

How far has the agency of man altered, and how far is it likely to alter, the surface of the earth, the divisions and boundaries assigned by nature, the climate and the production of the different parts of the globe; and, further, how far, when not actually transforming nature, is human agency giving nature the go-by? It should be borne in mind that science has effected, and is effecting transformation, partly by applying to old processes far more powerful machinery, partly by introducing new processes altogether; and that, as each new force is brought to light, lands and peoples are to a greater or less extent transformed. The world was laid out afresh by coal and steam. A new readjustment is taking place with the development of water power and oil power. Lands with no coal, but with fine water power or access to oil, are asserting themselves. Oil fuel is prolonging continuous voyages and making coaling stations superfluous. But of necessity it is the earth herself who gives the machinery for altering her own surface. The application of the machinery is contributed by the wit of man.

The surface of the earth consists of land and water. How far has human agency converted water into land or land into water, and how far, without actually transforming land into water and water into land, is it for practical human purposes altering the meaning of land and water as the great geographical divisions? A writer on the Fens of South Lincolnshire has told us: "The Romans, not content with appropriating land all over the world, added to their territory at home by draining lakes and reclaiming marshes." We can instance another great race which, while appropriating land all over the world, has added to it by reclaiming land from water, fresh or salt. The traveler from Great Britain to the most distant of the great British possessions, New Zealand, will find on landing at Wellington a fine street, Lambton Quay, the foreshore of the old beach, seaward of which now rise many of the city's finest buildings on land reclaimed from the sea; and instances of the kind might be indefinitely multipled. Now the amount of land taken from water by man has been taken more from fresh water than from sea, and, taken in all, the amount is infinitesimal as compared with the total area of land and water; but it has been very considerable in certain small areas of the earth's surface, and from these small areas have come races of men who have profoundly modified the geography and history of the world. This may be illus-

trated from the Netherlands and from Great Britain.

Motley, at the beginning of "The Dutch Republic," writes of the Netherlands: "A region, outcast of ocean and earth, wrested at last from both domains their richest treasures." Napoleon was credited with saying that the Netherlands were a deposit of the Rhine, and the rightful property of him who controlled the sources; and an old writer pronounced that Holland was the gift of the ocean and of the rivers Rhine and Meuse, as Egypt is of the river Nile. The crowning vision of Goethe's Faust is that of a free people on a free soil, won from the sea and kept for human habitation by the daily effort of man. Such has been the story of the Netherlands. The Netherlands, as a home for civilized men, were, and are, the result of reclamation, of dykes and polders. The kingdom has a constantly changing area of between 12,000 and 13,000 square miles. Mr. Marsh, in his book, set down the total amount gained to agriculture at the time he wrote "by dyking out the sea and by draining shallow bays and lakes" at some 1,370 square miles, which, he says, was one tenth of the kingdom; at the same time, he estimated that much more had been lost to the sea—something like 2,600 square miles. He writes that there were no important sea dykes before the thirteenth century, and that draining inland lakes did not begin till the fifteenth, when windmills came into use for pumping. In the nineteenth century steam pumps took the place of windmills, science strengthening an already existing process. Between 1815 and 1855, 172 square miles were reclaimed, and this included the Lake of Haarlem, some thirteen miles long by six in breadth, with an area of about seventy-three square miles. This was reclaimed between 1840 and 1853. At the present time, we are told, about forty square miles are being reclaimed annually in Holland; and meanwhile the Dutch government have in contemplation or in hand a great scheme for draining the Zuyder Zee, which amounts to recovering from the ocean land which was taken by it in historic times at the end of the fourteenth century. The scheme is to be carried out in thirty-three years and is to cost nearly sixteen million pounds. The reclamation is to be effected by an embankment across the mouth of this inland sea over eighteen miles long. The result will be to add 815 square miles of land to the kingdom of the Netherlands, 750 square miles of which will be fertile land, and in addition to create a much-needed freshwater lake with an area of 557 square miles; this lake is to be fed by one of the mouths of the Rhine.

London is partly built on marsh. The part of London where I live, Pimlico, was largely built on piles. A little way north, in the center of fashion, is Belgrave Square, and here a lady whom I used to know had heard her grandfather say that he had shot snipe. Take the City of London in the strict and narrow sense. The names of Moorfields and Fensbury or Finsbury are familiar to those who know the city. Stow, in his survey of London, over three hundred years ago, wrote of "The Moorfield which lieth without the postern called Moorgate. This field of old time was called the Moor. This fen or moor field stretching from the wall of the city betwixt Bishopsgate and the postern called Cripplegate to Fensbury and to Holywell continued a waste and unprofitable ground a long time." By 1527, he tells us, it was drained "into the course of Walbrook, and so into the Thames, and by these degrees was this fen or moor at length made main and hard ground which before, being overgrown with flags, sedges and rushes, served to no use." It is said that this fen or marsh had come

into being since Roman times. The reclamation which has been carried out in the case of London is typical of what has been done in numerous other cases. As man has become more civilized, he has come down from his earlier home in the uplands, has drained the valley swamps, and on the firm land thus created has planted the streets and houses of great cities.

The Romans had a hand in the draining of Romney Marsh in Sussex, and here nature cooperated with man, just as she has cooperated in the deltas of the great rivers, for the present state of the old Cinque Ports, Rye and Winchelsea, shows how much on this section of the English coast the sea has receded. But the largest reclamation was in East Anglia, where the names of the Fens and the Isle of Ely testify to what the surface once was. "For some of our fens," writes Holinshed, "are well known to be either of ten, twelve, sixteen, twenty or thirty miles in length. . . . Wherein also Elie, the famous isle, standeth, which is seven miles every way, and whereunto there is no access but by three causies." Arthur Young, in 1799, in his "General View of the Agriculture of the County of Lincoln," a copy of which he dedicated to that great friend of Australia, Sir Joseph Banks, who was a Lincolnshire landowner and a keen supporter of reclamation, wrote of the draining which had been carried out in Lincolnshire. "The quantity of land thus added to the kingdom has been great; fens of water, mud, wild fowl, frogs and agues have been converted to rich pasture and arable worth from 20 s. to 40 s. an acre . . . without going back to very remote periods, there can not have been less than 150,000 acres drained and improved on an average from 5 s. an acre to 25 s." 150,000 acres is about 234 square miles, but the amount reclaimed by draining in Lincolnshire in the seventeenth, eighteenth and nineteenth centuries seems to have been well over 500 square miles. The Fenlands, as a whole, extended into six counties. They were seventy miles in length, from ten to thirty miles broad, and covered an area of from 800 to 1,000 square miles. One estimate I have seen is as high as 1,200 square miles. Mr. Prothero, in his book on "English Farming, Past and Present," tells us that they were "in the seventeenth century a wilderness of bogs, pools and reed shoals—a vast morass from which here and there emerged a few islands of solid earth." In the seventeenth century a Dutch engineer, Vermuyden, was called in to advise, and the result of draining what was called after the peer who contracted for it the Bedford Level, together with subsequent reclamations, was to convert into ploughland and pasture large tracts which, in the words of an old writer, Dugdale, had been "a vast and deep fen, affording little benefit to the realm other than fish or fowl, with overmuch harbor to a rude and almost barbarous sort of lazy and beggarly people." In Lincolnshire there was a district called Holland, and in Norfolk one called Marshland, said to have been drained by, to quote Dugdale again, "those active and industrious people, the Romans."

The Dutch and the English, who thus added to their home lands by reclamation, went far and wide through the world, changing its face as they went. The Dutch, where they planted themselves, planted trees also; and when they came to land like their own Netherlands, again they reclaimed and empoldered. The foreshore of British Guiana, with its canals and sea defences, dating from Dutch times, is now the chief sugar-producing area in the British West Indies. If again in Australia man has been a geographical agency, he

learnt his trade when he was changing the face of his old home in the British Isles.

Instances of reclaiming land from water might be indefinitely multiplied. We might compare the work done by different nations. In Norway, for instance, Reclus wrote that "the agriculturists are now reclaiming every year forty square miles of the marshes and fiords." Miss Semple, who, in the "Influences of Geographic Environment," writes that "between the Elbe and Scheldt" (that is, including with the Netherlands some of North Germany) "more than 2,000 square miles have been reclaimed from river and sea in the past 300 years," tells us also that "the most gigantic dyke system in the world is that of the Hoangho, by which a territory of the size of England is won from the water for cultivation." Or we might take the different objects which have impelled men here and there to dry up water and bank out sea. Agriculture has not been the only object, nor yet reclaiming for town sites. Thus, in order to work the hematite iron mines at Hodbarrow, in Cumberland, an area of 170 acres was, in the years 1900–1904, reclaimed from the sea by a barrier over 1¼ miles long, designed by the great firm of marine engineers, Coode and Matthews, who built the Colombo breakwater. The reclaimed land, owing to the subsidence caused by the workings, is now much below the level of the sea. Here is an instance of reclamation not adding to agricultural or pastoral area, but giving mineral wealth, thereby attracting population and enriching a district.

How far has land been drowned by the agency of man? Again the total area is a negligible quantity, but again, relatively to small areas, it has been appreciable, and the indirect effects have been great. The necessities of town life are responsible for new lakes and rivers. Such are the great reservoirs and aqueducts by which water is being brought to New York from the Catskill Mountains, a work which the writer in the *Times* has described as "hardly second in magnitude and importance to the Panama Canal." In Great Britain cities in search of water supply have ordered houses, churches, fields to be drowned, and small lakes to come into existence. Liverpool created Lake Vyrnwy in Montgomeryshire, with a length of nearly five miles and an area of 1,121 acres. Birmingham is the parent of a similar lake in a wild Radnorshire valley near my old home. The water is not carried for anything like the distance from Mundaring to Kalgoorlie, and on a much greater scale than these little lakes in Wales is the reservoir now being formed in New South Wales by the Burrinjuck dam, on the Murrumbidgee River, which, as I read, is, or will be, forty-one miles long, and cover an area of twenty square miles. If I understand right, in this case, by holding up the waters of a river, a long narrow lake has been or is being called into existence. A still larger volume of water is gathered by the great Assouan dam, which holds up the Nile at the head of the First Cataract, washing, and at times submerging, the old temples on the Island of Philæ in midstream. First completed in 1902, the dam was enlarged and heightened by 1912; and the result of the dam is at the time of high Nile to create a lake of some 65 square miles in area, as well as to fill up the channel of the river for many miles up stream. Illustrations of artificial lakes might be multiplied from irrigation works in India. An official report on the state of Hyderabad, written some years ago, has the following reference to the tanks in the granitic country of that state: "There are no natural lakes, but from the earliest times advantage has been taken of the undulating character of the country to

dam up some low ground or gorge between two hills, above which the drainage of a large area is collected. Such artificial reservoirs are peculiar to the granitic country, and wherever groups of granite hills occur tanks are sure to be found associated with them." Take again the great ship canals. The Suez Canal runs for 100 miles from sea to sea, though for part of its course it runs through water, not through sand. It is constantly growing in depth and width. Its original depth was 26¼ feet; it is now, for nine tenths of its length, over 36 feet, and the canal is to be further deepened generally to over 39 feet. Its original width at the bottom was 72 feet; it is now, for most of its course, over 147 feet; in other words, the width has been more than doubled. A writer in the *Times* on the wonderful Panama Canal said: "The locks and the Gatun dam have entailed a far larger displacement of the earth's surface than has ever been attempted by the hand of man in so limited a space." Outside the locks the depth is 45 feet, and the minimum bottom width 300 feet. The official handbook of the Panama Canal says: "It is a lake canal as well as a lock canal, its dominating feature being Gatun Lake, a great body of water covering about 164 square miles." The canal is only fifty miles long from open sea to open sea, from shore line to shore line only forty. But in making it man, the geographical agency, has blocked the waters of a river, the Chagres, by building up a ridge which connects the two lines of hills between which the river flows, this ridge being a dam 1½ miles long, nearly half a mile wide at its base, and rising to 105 feet above sea-level, with the result that a lake has come into existence which is three quarters of the size of the Lake of Geneva, and extends beyond the limits of the Canal zone.

Mr. Marsh, in his book, referred to far more colossal schemes for turning land into water, such as flooding the African Sahara or cutting a canal from the Mediterranean to the Jordan and this submerging the basin of the Dead Sea, which is below the level of the ocean. The effect of the latter scheme, he estimated, would be to add from 2,000 to 3,000 square miles to the fluid surface of Syria. All that can be said is that the wild-cat schemes of one century often become the domesticated possibilities of the next and the accomplished facts of the third; that the more discovery of new lands passes out of sight the more men's energies and imagination will be concentrated upon developing and altering what is in their keeping; and that, judging from the past, no unscientific man can safely set any limit whatever to the future achievements of science.

But now, given that the proportion of land to water and water to land has not been, and assuming that it will not be, appreciably altered, has water, for practical purposes, encroached on land, or land on water? In many cases water transport has encroached on land transport. The great isthmus canals are an obvious instance; so are the great Canadian canals. The tonnage passing through the locks of the Sault St. Marie is greater than that which is carried through the Suez Canal. Waterways are made where there was dry land, and more often existing inland waterways are converted into sea-going ways. Manchester has become a seaport through its ship canal. The Clyde, in Mr. Vernon Harcourt's words, written in 1895, has been "converted from an insignificant stream into a deep navigable river capable of giving access to ocean-going vessels of large draught up to Glasgow." In 1758 the Clyde at low water at Glasgow was only 15 inches deep, and till 1818 no seagoing vessels came up to Glasgow. In 1895 the

depth at low water was from 17 to 20 feet, and steamers with a maximum draught of 25½ feet could go up to Glasgow. This was the result of dredging, deepening and widening the river, and increasing the tidal flow. The record of the Tyne has been similar. The effect of dredging the Tyne was that in 1895—I quote Mr. Harcourt again —"Between Shields and Newcastle, where formerly steamers of only 3 to 4 feet draught used to ground for hours, there is now a depth of 20 feet throughout at the lowest tides." It is because engineers have artificially improved nature's work on the Clyde and the Tyne that these rivers have become homes of shipbuilding for the whole world. Building training walls on the Seine placed Rouen, seventy-eight miles up the river, high among the seaports of France. The Elbe and the Rhine, the giant rivers Mississippi and St. Lawrence, and many other rivers, have, as we all know, been wonderfully transformed by the hand of the engineer.

But land in turn, in this matter of transport, has encroached upon sea. In old days, when roads were few and bad, when there were no railways, and when ships were small, it was all-important to bring goods by water at all parts as far inland as possible. In England there were numerous flourishing little ports in all the estuaries and up the rivers, which, under modern conditions, have decayed. No one now thinks of Canterbury and Winchester in connection with seaborne traffic; but Mr. Belloc, in "The Old Road," a description of the historical Pilgrims' Way from Winchester to Canterbury, points out how these two old-world cathedral cities took their origin and derived their importance from the fact that each of them, Canterbury in particular, was within easy reach of the coast, where a crossing from France would be made; each on a river—in the case of Canterbury on the Stour just above the end of the tideway. In the days when the Island of Thanet was really an island, separated from the rest of Kent by an arm of the sea, and when the present insignificant river Stour was, in the words of the historian J. R. Green, "a wide and navigable estuary," Canterbury was a focus to which the merchandise of six Kentish seaports was brought, to pass on inland; it was in effect practically a seaport. Now merchandise, except purely local traffic, comes to a few large ports only, and is carried direct by rail to great distant inland centers. Reclus wrote that bays are constantly losing in comparative importance as the inland ways of rapid communication increase; that, in all countries intersected with railways, indentations in the coast-line have become rather an obstacle than an advantage; and that maritime commerce tends more and more to take for its starting-place ports situated at the end of a peninsula. He argues, in short, that traffic goes on land as far out to sea as possible instead of being brought by water as far inland as possible. He clearly overstated the case, but my contention is that, for human purposes, the coast-line, though the same on the map, has practically been altered by human agency. Ports have been brought to men as much as men to ports. We see before our eyes the process going on of bridging India to Ceylon so as to carry goods and passengers as far by land as possible, and in Ceylon we see the great natural harbor of Trincomalee practically deserted and a wonderful artificial harbor created at the center of population, Colombo.

But let us carry the argument a little further. Great Britain is an island. Unless there is some great convulsion of nature, to all time the Strait of Dover will separate it from the continent of Europe.

Yet we have at this moment a renewal of the scheme for a Channel tunnel, and at this moment men are flying from England to France and France to England. Suppose the Channel tunnel to be made; suppose flying to be improved—and it is improving every day—what will become of the island? What will become of the sea? They will be there and will be shown on the map, but to all human intents and purposes the geography will be changed. The sea will no longer be a barrier, it will no longer be the only high-road from England to France. There will be going to and fro on or in dry land, and going to and fro neither on land nor on sea. Suppose this science of aviation to make great strides, and heavy loads to be carried in the air, what will become of the ports, and what will become of sea-going peoples? The ports will be there, appearing as now on the map, but Birmingham goods will be shipped at Birmingham for foreign parts, and Lithgow will export mineral direct, saying good-bye to the Blue Mountains and even to Sydney harbor.

Now, in saying this I may well be told by my scientific colleagues that it is all very well as a pretty piece of fooling, but that it is not business. I say it as an unscientific man with a profound belief in the limitless possibilities of science. How long is it since it was an axiom that, as a lump of iron sinks in water, a ship made of iron could not possibly float? Is it fatuous to contemplate that the conquest of the air, which is now beginning, will make it a highway for commercial purposes? We have aeroplanes already which settle on the water and rise again; we are following on the track of the gulls which we wonder at far away in the limitless waste of ocean. A century and a half ago the great Edmund Burke ridiculed the idea of representatives of the old North American colonies sitting in the Imperial Parliament; he spoke of any such scheme as fighting with nature and conquering the order of Providence; he took the distance, the time which would be involved—six weeks from the present United States to London. If any one had told him that what is happening now through the applied forces of science might happen, he would have called him a madman. Men think in years, or at most in lifetimes; they ought sometimes to think in centuries. I believe in Reclus's words, "All man has hitherto done is a trifle in comparison with what he will be able to effect in future." Science is like a woman. She says no again and again, but means yes in the end.

In dealing with land and water I have touched upon natural divisions and natural boundaries, which are one of the provinces of geography. Flying gives the go-by to all natural divisions and boundaries, even the sea; but let us come down to the earth. Isthmuses are natural divisions between seas; the ship canals cut them and link the seas—the canal through the Isthmus of Corinth, the canal which cuts the Isthmus of Perekop between the Crimea and the mainland of Russia, the Baltic Canal, the Suez Canal, the Panama Canal. The Suez Canal, it will be noted, though not such a wonderful feat as the Panama Canal, is more important from a geographical point of view, in that an open cut has been made from sea to sea without necessity for locks, which surmount the land barrier but more or less leave it standing. Inland, what are natural divisions? Mountains, forests, deserts, and, to some extent, rivers. Take mountains. "High, massive mountain systems," writes Miss Semple, "present the most effective barriers which man meets on the land surface of the earth." But are the Rocky Mountains, for instance, boundaries, dividing lines, to anything like the extent that they were now that railways go through and

over them, carrying hundreds of human beings back and fore day by day? On what terms did British Columbia join the Dominion of Canada? That the natural barrier between them should be pierced by the railway. Take the Alps. The canton Ticino, running down to Lake Maggiore, is politically in Switzerland; it is wholly on the southern side of the Alps. Is not the position entirely changed by the St. Gothard tunnel, running from Swiss territory into Swiss territory on either side of the mountains?

If, in the Bible language, it requires faith to remove mountains, it is not wholly so with other natural boundaries. Forests were, in old days, very real natural dividing lines. They were so in England, as in our own day they have been in Central Africa. Between forty and fifty years ago, in his "Historical Maps of England," Professor C. H. Pearson, whose name is well known and honored in Australia, laid down that England was settled from east and west, because over against Gaul were heavy woods, greater barriers than the sea. Kent was cut off from Central England by the Andred Weald, said to have been, in King Alfred's time, 120 miles long and 30 broad. Here are Professor Pearson's words: "The axe of the woodman clearing away the forests, the labor of nameless generations reclaiming the fringes of the fens or making their islands habitable, have gradually transformed England into one country, inhabited by one people. But the early influences of the woods and fens are to isolate and divide." Thus the cutting down of trees is sometimes a good, not an evil, and there are some natural boundaries which man can wholly obliterate.

Can the same be said of deserts? They can certainly be pierced, like isthmuses and like mountains. The Australian desert is a natural division between western and south Australia. The desert will be there, at any rate for many a long day after the transcontinental railway has been finished, but will it be, in anything like the same sense as before, a barrier placed by nature and respected by man? Nor do railways end with simply giving continuous communication, except when they are in tunnels. As we all know, if population is available, they bring in their train development of the land through which they pass. Are these deserts of the earth always going to remain "deserts idle"? Is man going to obliterate them? In the days to come, will the desert rejoice and blossom as the rose? What will dry farming and what will afforestation have to say? In the evidence taken in Australia by the Dominions Royal Commission, the Commissioner for Irrigation in New South Wales tells us that "the dry farming areas are carried out westward into what are regarded as arid lands every year," and that, in his opinion, "we are merely on the fringe of dry farming" in Australia. A book has lately been published entitled "The Conquest of the Desert." The writer, Dr. Macdonald, deals with the Kalahari Desert in South Africa, which he knows well, and for the conquest of the desert he lays down that three things are essential—population, conservation and afforestation. He points out in words which might have been embodied in Mr. Marsh's book, how the desert zone has advanced through the reckless cutting of trees, and how it can be flung back again by tree barriers to the sand dunes. By conservation he means the system of dry farming so successful in the United States of America, which preserves the moisture in the soil and makes the desert produce fine crops of durum wheat without a drop of rain falling upon it from seedtime to harvest, and he addresses his book "to the million settlers of to-morrow upon the dry and desert lands

of South Africa." If the settlers come, he holds that the agency of man, tree-planting, ploughing and harrowing the soil, will drive back and kill out the desert. The effect of tree-planting in arresting the sand dunes and reclaiming desert has been very marked in the Landes of Gascony. Here, I gather from Mr. Perkins's report, are some 3,600 square miles of sandy waste, more than half of which had, as far back as 1882, been converted into forest land, planted mainly with maritime pines.

What, again, will irrigation have to say to the deserts? Irrigation, whether from underground or from overground waters, has already changed the face of the earth, and as the years go on, as knowledge grows and wisdom, must inevitably change it more and more. I read of underground waters in the Kalahari. I read of them too in the Libyan Desert. In the *Geographical Journal* for 1902 it is stated that at that date nearly 22,000 square miles in the Algerian Sahara had been reclaimed with water from artesian wells. What artesian and sub-artesian water has done for Australia you all know. If it is not so much available for agricultural purposes, it has enabled flocks and herds to live and thrive in what would be otherwise arid areas. Professor Gregory, Mr. Gibbons Cox, and others have written on this subject with expert knowledge; evidence has been collected and published by the Dominions Royal Commission, but I must leave to more learned and more controversial men than I am to discuss whether the supplies are plutonic or meteoric, and how far in this matter you are living on your capital.

If we turn to irrigation from overground waters, I hesitate to take illustrations from Australia, because my theme is the blotting out of the desert, and most of the Australian lands which are being irrigated from rivers, and made scenes of closer settlement, would be libeled if classed as desert. Mr. Elwood Mead told the Royal Commission that the state irrigation works in Victoria, already completed or in process of construction, can irrigate over 600 square miles, and that, if the whole water supply of the state were utilized, more like 6,000 square miles might be irrigated. The Burrinjuck scheme in New South Wales will irrigate, in the first instance, not far short of 500 square miles, but may eventually be made available for six times that area. If we turn to irrigation works in India, it appears from the second edition of Mr. Buckley's work on the subject, published in 1905, that one canal system alone, that of the Chenab in the Punjab, had, to quote his words, turned "some two million acres of wilderness (over 3,000 square miles) into sheets of luxuriant crops." "Before the construction of the canal," he writes, "it was almost entirely waste, with an extremely small population, which was mostly nomad. Some portion of the country was wooded with jungle trees, some was covered with small scrub camel thorn, and large tracts were absolutely bare, producing only on occasions a brilliant mirage of unbounded sheets of fictitious water." The Chenab irrigation works have provided for more than a million of human beings; and, taking the whole of India, the Irrigation Commission of 1901–03 estimated that the amount of irrigated land at that date was 68,750 square miles; in other words, a considerably larger area than England and Wales. Sir William Willcocks is now reclaiming the delta of the Euphrates and Tigris. The area is given as nearly 19,000 square miles, and it is described as about two thirds desert and one third freshwater swamp. Over 4,000 square miles of the Gezireh Plain, between the Blue and the White Nile, are about to be reclaimed, mainly for cotton cultivation,

by constructing a dam on the Blue Nile at Sennaar and cutting a canal 100 miles long which, if I understand right, will join the White Nile thirty miles south of Khartoum.

With the advance of science, with the growing pressure of population on the surface of the earth, forcing on reclamation as a necessity for life, is it too much to contemplate that human agency in the coming time will largely obliterate the deserts which now appear on our maps? It is for the young peoples of the British Empire to take a lead in—to quote a phrase from Lord Durham's great report—"the war with the wilderness," and the great feat of carrying water for 350 miles to Kalgoorlie, in the very heart of the wilderness, shows that Australians are second to none in the ranks of this war.

It is a commonplace that rivers do not make good boundaries because they are easy to cross by boat or bridge. Pascal says of them that they are "des chemins qui marchent" (roads that move), and we have seen how these roads have been and are being improved by man. "Rivers unite," says Miss Semple; and again, "Rivers may serve as political lines of demarcation, and therefore fix political frontiers, but they can never take the place of natural boundaries. All the same, in old times, at any rate, rivers were very appreciable dividing lines, and when you get back to something like barbarism, that is to say in time of war, it is realized how powerful a barrier is a river. Taking, then, rivers as in some sort natural boundaries, or treating them only as political boundaries, the point which I wish to emphasize is that they are becoming boundaries which, with modern scientific appliances, may be shifted at the will of man. In the days to come the diversion of rivers may become the diversion of a new race of despotic rulers with infinitely greater power to carry out their will or their whim than the Pharaohs possessed when they built the Pyramids. You in Australia know how thorny a question is that of the control of the Murray and its tributaries. There are waterways conventions between Canada and the United States. Security for the headwaters of the Nile was, and is, a prime necessity for the Sudan and Egypt. The Euphrates is being turned from one channel into another. What infinite possibilities of political and geographical complications does man's growing control over the flow of rivers present!

Thus I have given you four kinds of barriers or divisions set by nature upon the face of the earth—mountains, forests, deserts, rivers. The first, the mountains, man can not remove, but he can and he does go through them to save the trouble and difficulty of going over them. The second, the forests, he has largely cleared away altogether. The third, the deserts, he is beginning to treat like the forests. The fourth, the rivers, he is beginning to shift when it suits his purpose and to regulate their flow at will.

I turn to climate. Climates are hot or cold, wet or dry, healthy or unhealthy. Here our old friends the trees have much to say. Climates beyond dispute become at once hotter and colder when trees have been cut down and the face of the earth has been laid bare; they become dryer or moister according as trees are destroyed or trees are planted and hold the moisture; the cutting and planting of timber affects either one way or the other the health of a district. The tilling of the soil modifies the climate. This has been the case, according to general opinion, in the northwest of Canada, though I have not been able to secure any official statistics on the subject. In winter time broken or ploughed land does not hold the snow and ice to the same

extent as the unbroken surface of the prairie; on the other hand, it is more retentive at once of moisture and of the rays of the sun. The result is that the wheat zone has moved further north, and that the intervention of man has, at any rate for agricultural purposes, made the climate of the great Canadian northwest perceptibly more favorable than it was. In Lord Strathcona's view, there was some change even before the settlers came in, as soon as the rails and telegraph lines of the Canadian Pacific Railway were laid. He told me that in carrying the line across a desert belt it was found that, within measurable distance of the rail and the telegraph line, there was a distinct increase of dew and moisture. I must leave it to men of science to say whether this was the result of some electrical or other force, or whether what was observed was due simply to a wet cycle coinciding with the laying of the rails and the erection of the wires. I am told that it is probably a coincidence of this kind, which accounts for the fact that in the neighborhood of the Assouan dam there is at present a small annual rainfall, whereas in past years the locality was rainless. Reference has already been made to the effect of cultivation in the Kalahari Desert in increasing the storage of moisture in the soil. But it is when we come to the division between healthy and unhealthy climates that the effect of science upon climate is most clearly seen. The great researches of Ross, Manson and many other men of science, British and foreign alike, who have traced malaria and yellow fever back to the mosquito, and assured the prevention and gradual extirpation of tropical diseases, bid fair to revolutionize climatic control. Note, however, that in our penitent desire to preserve the wild fauna of the earth we are also establishing preserves for mosquitoes, trypanosomes and the tsetse fly.

Nowhere have the triumphs of medical science been more conspicuous than where engineers have performed their greatest feats. De Lesseps decided that Ismailia should be the headquarters of the Suez Canal, but the prevalence of malaria made it necessary to transfer the headquarters to Port Said. In 1886 there were 2,300 cases of malaria at Ismailia; in 1900 almost exactly the same number. In 1901 Sir Ronald Ross was called in to advise; in 1906 there were no fresh cases, and the malaria has been stamped out. De Lessep's attempt to construct the Panama Canal was defeated largely, if not mainly, by the frightful death-rate among the laborers; 50,000 lives are said to have been lost, the result of malaria and yellow fever. When the Americans took up the enterprise they started with sending in doctors and sanitary experts, and the result of splendid medical skill and sanitary administration was that malaria and yellow fever were practically killed out. The Panama Canal is a glorious creation of medical as well as of engineering science, and this change of climate has been mainly due to reclamation of pools and swamps, and to cutting down bush, for even the virtuous trees, under some conditions, conduce to malaria. Man is a geographical agency, and in no respect more than in the effect of his handiwork on climate, for climate determines products, human and others. Science is deciding that animal pests shall be extirpated in the tropics, and that there shall be no climates which shall be barred to white men on the ground of danger of infection from tropical diseases.

If we turn to products, it is almost superfluous to give illustrations of the changes wrought by man. As the incoming white man has in many places supplanted the colored aboriginal, so the plants and the living creatures brought in by the white man have in many cases, as you know well,

ousted the flora and fauna of the soil. Here is one well-known illustration of the immigration of plants. Charles Darwin, on the voyage of the *Beagle,* visited the island of St. Helena in the year 1836. He wrote "that the number of plants now found on the island is 746, and that out of these fifty-two alone are indigenous species." The immigrants, he said, had been imported mainly from England, but some from Australia, and, he continued, "the many imported species must have destroyed some of the native kinds, and it is only on the highest and steepest ridges that the indigenous flora is now predominant."

Set yourselves to write a geography of Australia as Australia was when first made known to Europe, and compare it with a geography now. Suppose Australia to have been fully discovered when Europeans first reached it, but consider the surface then and the surface now, and the living things upon the surface then and now. Will not man have been found to be a geographical agency? How much waste land, how many fringes of desert have been reclaimed? The wilderness has become pasture land, and pasture land, in turn, is being converted into arable. The Blue Mountains, which barred the way to the interior, are now a health resort. Let us see what Sir Joseph Banks wrote after his visit to Australia on Captain Cook's first voyage in 1770. He has a chapter headed "Some Account of that part of New Holland now called New South Wales." New Holland he thought "in every respect the most barren country I have seen"; "the fertile soil bears no kind of proportion to that which seems by nature doomed to everlasting barrenness." "In the whole length of coast which we sailed along there was a very unusual sameness to be observed in the face of the country. Barren it may justly be called, and in a very high degree, so far, at least, as we saw." It is true that he only saw the land by the sea, but it was the richer eastern side of Australia, the outer edge of New South Wales and Queensland. What animals did he find in Australia? He "saw an animal as large as a greyhound, of a mouse color, and very swift." "He was not only like a greyhound in size and running, but had a tail as long as any greyhound's. What to liken him to I could not tell." Banks had a greyhound with him, which chased this animal. "We observed, much to our surprise, that, instead of going upon all fours, this animal went only on two legs, making vast bounds." He found out that the natives called it kangooroo, and it was "as large as a middling lamb." He found "this immense tract of land," which he said was considerably larger than all Europe, "thinly inhabited, even to admiration, at least that part of it that we saw." He noted the Indians, as he called them, whom he thought "a very pusillanimous people." They "seemed to have no idea of traffic"; they had "a wooden weapon made like a short scimitar." Suppose a new Sir Joseph Banks came down from the planet Mars to visit Australia at this moment, what account would he give of it in a geographical handbook for the children of Mars? He would modify the views about barrenness, if he saw the cornfields and flocks and herds; if he visited Adelaide, he would change his opinion as to scanty population, though not so, perhaps, if he went to the back blocks. He would record that the population was almost entirely white, apparently akin to a certain race in the North Sea, from which, by tradition, they had come; that their worst enemies could not call them pusillanimous; that they had some ideas of traffic, and used other weapons than a wooden scimitar; and he would probably give the

first place in animal life not to the animal like a greyhound on two legs; but to the middling lamb, or perhaps to the ubiquitous rabbit. Australia is the same island continent that it always was; there are the same indentations of coast, the same mountains and rivers, but the face of the land is different. In past years there was no town, and the country was wilderness; on the surface of the wilderness many of the living things were different; and from under the earth has come water and mineral, the existence of which was not suspected. A century hence it will be different again, and I want to see sets of maps illustrating more clearly than is now the case the changes which successive generations of men have made and are making in the face of Australia and of the whole earth.

More than half a century ago Buckle, in his "History of Civilization," wrote: "Formerly the richest countries were those in which nature was most bountiful; now the richest countries are those in which man is most active. For in our age of the world, if nature is parsimonious we know how to compensate her deficiencies. If a river is difficult to navigate, or a country difficult to traverse, an engineer can correct the error and remedy the evil. If we have no rivers we make canals; if we have no natural harbors we make artificial ones." These words have a double force at the present day and in the present surroundings, for nowhere has man been more active as a geographical agency than in Australia; and not inside Australia only, but also in regard to the relations of Australia to the outside world.

An island continent Australia is still, and always will be, on the maps. It always will be the same number of miles distant from other lands; but will these maps represent practical everyday facts? What do miles mean when it takes a perpetually diminishing time to cover them? Is it not truer to facts to measure distances, as do Swiss guides, in Stunden (hours)? What, once more, will an island continent mean if the sea is to be overlooked and overflown? The tendency is for the world to become one; and we know perfectly well that, as far as distance is concerned, for practical purposes the geographical position of Australia has changed through the agency of scientific man. If you come to think of it, what geography has been more concerned with than anything else, directly or indirectly, is distance. It is the knowledge of other places not at our actual door that we teach in geography, how to get there, what to find when we get there, and so forth. The greatest revolution that is being worked in human life is the elimination of distance, and this elimination is going on apace. It is entering into every phase of public and private life, and is changing it more and more. The most difficult and dangerous of all Imperial problems at this moment is the color problem, and this has been entirely created by human agency, scientific agency, bringing the lands of the colored and the white men closer together. Year after year, because distance is being diminished, coming and going of men and of products is multiplying; steadily and surely the world is becoming one continent. This is what I want geographers to note and the peoples to learn. Geographers have recorded what the world is according to nature. I want them to note and teach others to note how under an all-wise Providence it is being subdued, replenished, recast and contracted by man.

Charles P. Lucas

PROFESSOR HUGO KRONECKER

Hugo Kronecker, for the last thirty years professor of physiology at the University of Berne, Switzerland, died June 6. Although

seventy-five years old, death surprised him in the midst of scientific activity. He attended the last meeting of the German Congress of Physiologists at Berlin where, on the fifth of June, he demonstrated experiments which should support the neurogenic theory of the origin of the heart beat. On his way home he stopped at Nauheim, to inspect an apparatus which he installed there for the study and use in cardiac diseases. His death came there, suddenly, like a flash—perhaps by means of the cardiac center which he discovered thirty years before.

Kronecker was one of the last of a classical period in German physiology. He was pupil, assistant and intimate friend of the master minds of that period: Helmholtz, du Bois-Reymond and Carl Ludwig. At the same time, he was master and friend of many leading physiologists of a later generation and of many countries; he was an international leader in his science.

He was born in Liegnitz, Prussia, from a well-to-do family with scientific proclivities. The celebrated mathematician Leopold Kronecker was his older brother. After finishing his general education at the Gymnasium in Liegnitz he studied medicine in Berlin, Heidelberg and Pisa (Italy). In Heidelberg he came under the special influence of Helmholtz, who introduced Kronecker into the science of physiology. The problem of muscular fatigue which Kronecker studied first under Helmholtz and which he treated in his thesis became the source of many important investigations which he carried out at various times during his scientific career. In 1865 he became assistant to Traube. This celebrated clinician was the first man to employ experimental physiology for the study of medical problems. It was probably due to the early influence of Traube that Kronecker acquired the inclination to make results, obtained in physiological studies, available for clinical medicine. On account of a temporary pulmonary affection, Traube sent him to Italy where he stayed for some time, an incident which left a mark upon Kronecker's future activities. The acquisition of the knowledge and the use of the Italian language was unquestionably a factor in his future intimate relations with the Italian physiologists. He recovered his health and even served in the Prussian wars with Austria and France. In the Franco-Prussian war he received the iron cross for bravery. In 1868 he entered Ludwig's celebrated "Physiologische Anstalt zu Leipzig," where he remained until 1876, becoming assistant in 1871, and professor extraordinarus in 1874. In 1877 he was called to Berlin to become the head of the division of experimental physiology in the Institute of Physiology which had been recently organized by du Bois-Reymond. In 1884 he was called to Berne, where he filled the chair of physiology until the last day of his life.

Kronecker's scientific activities extended over more than half a century; his thesis appeared 1863. But the investigation which raised him to the rank of a first-class physiologist was his work on "fatigue and recovery of striated muscles" published from Ludwig's laboratory in 1872. The careful planning of the experiments, the exactness and skill with which they were executed and the sharp analysis which permitted the derivation of general laws put a classical stamp upon this piece of work; its celebrated tracings were the starting point for many future ergographic studies. The later work during his Leipzig period was mainly devoted to the cardiac muscle; some of the results found a permanent place in physiology. I may mention here the development of the "all or none" law; the loss of irritability of the cardiac muscle during systole (refractory period, Marey); the importance of inorganic salts for the heart beat (with Merunowitz and others). Of his many investigations during his Berlin period I should mention the studies which led up to the use of transfusion as a life-saving means (present-day writers do not seem to know that Kronecker was the inventor of this method); the extensive studies (with his colaborers) on the physiology of deglutition; the discovery of a coordinating center in the heart. I wish to record here the fact that Kronecker had an essential share in the development of the clinically important methods of studying blood pressure in human beings. The

first human sphygmomanometric studies are usually ascribed to Von Basch; but Von Basch carried out these studies in Kronecker's laboratory and under his direction and assistance. I can testify to that as an eye-witness.

During his long stay in Berne a great many physiological subjects were investigated in conjunction with advanced coworkers or students. The results were usually published under the name of the coworkers. In the last years of his life he was intensely interested in experiments which could throw light upon the origin of the heart beat; he was a firm believer in the neurogenic theory.

A subject in which he took a great interest in the last two decades of his life was the nature and origin of mountain disease. The Swiss government, before granting permission to build the now famous Jungfrau railroad, asked Kronecker to pass an opinion, whether going up a high mountain in a railway would be accompanied by mountain disease and other disturbances of health. This gave rise to numerous studies connected with this question. Kronecker organized a party of sixty, who ascended the Zermat Breithorn; some of the party were carried up, in order to eliminate muscular action. Circulation, respiration and other functions were then investigated. The problem was also studied in pneumatic chambers with lowered atmospheric pressure. Kronecker came to the conclusion that the syndrome of mountain disease was primarily due to mechanical causes, to a stasis in the intrapulmonary veins, brought about by rarification of the air in higher altitudes. Kronecker's publications gave rise to many international studies which caused the Italian physiologist Mosso, with the aid of Kronecker, to establish an international institute on Monte Rosa for the study of physiological phenomena in the mountains.

Kronecker was a master in physiological methods; he invented many instruments which found a permanent place in the methods of experimental physiology, of which I shall mention here only his well-known induction coil, divided in units, the "perfusion canula" and the frog heart manometer. The perfusion canula (or its modification) has been and still is extensively used in pharmacological studies upon the frog's heart.

In the seventies, during Kronecker's stay at Leipzig, Ludwig's physiological institute was an international center for physiology and physiologists. Many English, Italian, American, Russian, Belgian, Scandinavian and French physiologists received there their training in physiology. Kronecker, who spoke many languages fluently, has been of great assistance to them. With his very kind, unselfish nature he was always ready to help them with his rare experimental skill and in every other direction. Many who worked there during that period bear witness that Kronecker was the "soul" of the laboratory. Here he formed strong bonds of a lifelong friendship with men who became later international leaders in science. I need only mention here Bowditch and Minot of the United States; Lauder Brunton, Gaskell and Schäfer of England; Alberto Mosso and Luciani of Italy; Paul Heger of Belgium and Holmgren of Sweden. Very few men had the happiness of having so many true friends as Kronecker, and few could be a truer friend than he. He had the esteem and affection of all who had the good fortune to know him well.

His international, cordial relations to so many physiologists of so many countries was not a small factor in the success of the International Congress of Physiologists, which was founded by Michael Foster and Kronecker. In his obituary of Sir Michael Foster, Gaskell states that "when the International Medical Congress met in London in 1881 he (Foster) and Kroneceker together drew up a scheme for a separate International Congress of Physiology to meet every three years and a committee was formed." According to Heger the final decision, to call that Congress into being, was made by a group of physiologists who met September, 1888, in Kronecker's house in Berne. The third International Congress met in Berne under Kronecker's presidency.

Kronecker was also the chief founder and for some time the president of the Institut Marey in Paris, an international institution

for the study of physiology by the newest and most approved methods.

The Hallerianum, Kronecker's magnificent physiological laboratory in Berne, has been for years an international center for physiological investigators. English, American, Italian and Russian students went there to learn methods and to be initiated in physiological research. Well-known physiologists often worked in this laboratory, for instance Cyon, Gamgey, Heger and others. At his attractive home, presided over gracefully by Mrs. Kronecker, a cultured lady and an accomplished linguist, one often met celebrated scientists from all over the world. Kühne, Mosso, Bowditch, Schäfer and Foster were often there.

Kronecker was a foreign member of our National Academy of Sciences, of the Royal Society and of many European Academies. He had conferred upon him honorary degrees from a great many universities. In England alone he received the degree of LL.D. from the universities of Glasgow, Aberdeen, St. Andrews and Edinburgh, and the degree of D.Sc. from Cambridge.

He had pupils all over the world. Of American investigators who worked under Kronecker at one time or another I shall mention only the following: Mills, Stanley Hall, Cushing, Gies, H. C. Jackson, H. C. Wood, Jr., Cutter, Carter, Busch, Mühlberg, Mays, McGuire, Arnold and Meltzer.

Before concluding I wish to call attention to the following few incidents which bear witness to the nobility of Kronecker's character. The phenomenon of the "refractory period" which is generally ascribed to Marey, was observed and clearly described by Kronecker one year before Marey. Kronecker never made any effort for the recognition of his priority, and both physiologists remained intimate friends during their entire life. I have mentioned above that Kronecker had a share, at least equal to that of Von Basch, in being one of the first who introduced the era of studying blood pressure in human beings. But when Von Basch and others neglected to give him credit, we find Kronecker nowhere making an effort to obtain his rights.

Kronecker's studies of the nature of mountain disease was a stimulus which gave rise to researches on that subject by many other investigators, among whom I shall mention Zuntz and Loewy and A. Mosso, who came to results differing from those of Kronecker. It was, however, in Kronecker's laboratory that Loewy made the analyses of his results, and I have been a witness of the attractive scene when Mosso was introduced by Kronecker to his students to lecture on Mosso's theory of acapnia as the cause of mountain disease, a theory entirely at variance with that of his own.

Kronecker had many scientific disputes and was often energetic and perseverant in the defense of his views. But he never permitted a personal note to slip into his discussions.

Physiology lost in Kronecker a master and a leader, and numerous physiologists all over the world lost in him a noble and kind-hearted friend.

S. J. MELTZER

ROCKEFELLER INSTITUTE

SCIENTIFIC NOTES AND NEWS

DR. A. PENCK, professor of geography at Berlin; Dr. F. von Luschan, professor of anthropology in the same university, and Dr. J. Walther, professor of geology and paleontology at Halle, are among the German men of science who accepted invitations to attend the Australian meeting of the British Association. It is said that there is some anxiety as to how they shall return home. If press despatches are to be believed, several German astronomers, including Professors Kempff and Ludendorf, who had gone to the Crimea to observe the eclipse of the sun, have been taken prisoners and their scientific instruments confiscated.

THE Paris Academy of Sciences has placed itself at the disposal of the national defense. This resolution having been communicated to the government, members have been placed on commissions on the subjects of wireless telegraphy, aviation, explosives, hygiene and medicine. The academy is said to be continuing its meetings. A paper was presented at the last meeting of which reports are at hand on the recent eclipse of the sun by Messrs. Baillaud and Bigourdan, of the Paris Observatory.

THE Paris Academy of Medicine has decided unanimously that all its members will place themselves at the disposal of the government for any purpose for which they may be useful to the country. It has asked to be given the necessary animals and apparatus for manufacturing and applying small-pox and antityphoid vaccines.

THE British pharmaceutical committee, which is advising the government on the question of the rise in price of various drugs, is said to be holding frequent meetings. It consists of Messrs. Edmund White, E. T. Nethercoat, C. A. Hill, John C. Umney and W. J. U. Woolcock. Information is in the hands of the committee to the effect that the prices of certain drugs are inflated by reason of the action of particular dealers.

DR. AUG. AGNEUR, formerly professor of medicine at Lyons, and recently minister of education in the French government, has become minister of marine.

MR. ADOLPH ROLLOFF, director of the State Botanical Garden in Tiflis, Russia, is visiting the botanical gardens of the United States.

AN Institute of Oceanography has been established in Spain under the direction of Professor Odón de Buen.

THE Ohio State Board of Administration has established a psychological bureau to study and care for juvenile delinquents. In addition to the chief of the bureau, whose salary is $3,500 a year, a staff of eight assistants is planned, including three psychologists, a diagnostician and a bacteriologist. Dr. Thomas H. Haines, professor of psychology in the Ohio State University, has been appointed chief of the bureau.

THE Thirteenth Intercollegiate Geological Excursion will be held in the vicinity of Daltin on October 16 and 17, under the direction of Professor B. K. Emerson. A preliminary meeting will be held at the Wendell in Pittsfield on October 16 at 7:30.

THE home of Mr. Wallace Craig, at Orono, Me., was ruined by fire on August 16. The pigeons whose social behavior was under investigation were destroyed. However, the experiments on these individual birds were practically finished, and after rebuilding and buying a new flock of pigeons for observation, Mr. Craig will write up the results of his investigation.

PROFESSOR OLIVER C. LESTER, of the University of Colorado, has been in charge of a geological survey party studying the radium deposits in the southern part of the state.

DR. J. J. TAUBERHAUS, previously assistant pathologist of the Delaware College Agricultural Experiment Station, has been promoted to be associate research plant pathologist.

DR. HAROLD C. BRYANT, assistant curator of birds in the University of California museum of vertebrate zoology, who for the past year has engaged in studying the game birds of California, has accepted a position with the California State Fish and Game Commission. Although research work on the game birds and mammals of the state will be carried on, his work will be largely educational, as the commission believes that the protection and preservation of game is more effectually furthered by an appreciation of the value of this resource than through the maintenance of a large police force. Dr. Bryant's work on game birds in the museum of vertebrate zoology will be assumed by Tracy I. Storer, M.S., of the department of zoology of the University of California.

DR. ADOLF REMELE, professor in the forest school at Eberswald, has celebrated his seventy-fifth birthday and the fiftieth anniversary of his doctorate.

DR. EUGENE KORSCHEL, professor of zoology at Marburg, has been elected rector of the university for the coming year.

DR. AUGUST GÄRTNER, professor of hygiene at Jena, has retired from active service.

"THE Nature and Control of Hunger" was the subject of two lectures at the University of Chicago on August 19 and 20, by Associate Professor Anton Julius Carlson, of the department of physiology. On August 21 Associate Professor Henry Chandler Cowles, of the department of botany, concluded his series

of illustrated lectures on "Botanical Rambles in the West," the subject of this lecture being "Our Southwestern Desert."

DR. THOMAS H. GLENN, formerly in charge of the pathologic and bacteriologic laboratories of the Northwestern University, Chicago, has been placed in charge of the clinical and Röntgen-ray laboratories now being installed at Fort Dodge.

PROFESSOR KR. BIRKELAND returned to Christiania in July after a sojourn of seven months in Africa, where he continued his researches on the zodiacal light. He will return in October and continue the observations for three years.

A COURSE of twelve lectures on the theory and practise of radio-telegraphy will be delivered by Professor J. A. Fleming at University College, London, on Wednesdays at 5 P.M., beginning on October 28.

DR. JAMES ELLIS GOW, professor of botany in Coe College, the author of contributions on the embryology and morphology of plants, has died at the age of thirty-seven years.

WE have to record somewhat late the death of Overton Westfield Price, at one time associate forester of the U. S. Forest Service, for the internal administration of which he was largely responsible during the term of office of Mr. Pinchot.

SIR JOHN BENJAMIN STONE, for many years a member of the British parliament, known to scientific men for his photographs of scientific places, objects and men, has died at the age of seventy-six years.

UNIVERSITY AND EDUCATIONAL NEWS

THE Medical School of Western Reserve University receives by the will of Liberty E. Holden a bequest said to be nearly one million dollars. The fund is to be known as the Albert Fairchild Holden Foundation, in memory of Mr. Holden's son.

DR. HERMON CAREY BUMPUS, business manager of the University of Wisconsin, formerly director of the American Museum of Natural History, has been elected president of Tufts College.

THE *Journal* of the American Medical Association states that Dr. Daniel A. K. Steele has been appointed senior dean and head of the department of surgery in the college of medicine of the University of Illionois; Dr. Charles Spencer Williamson, professor of medicine and head of the department; Dr. Charles Summer Bacon, professor of obstetrics and head of the department of obstetrics and gynecology; Dr. Julius Hays Hess, associate professor of pediatrics and head of the division of pediatrics; Dr. Norval Pierce, professor of otology; Dr. Joseph C. Beck, associate professor of laryngology and rhinology and head of the division; Dr. Oscar Eugene Nadeau, instructor in surgical pathology; Dr. A. O. Shoklee, associate professor of pharmacology; Dr. Roy L. Moodie, instructor in anatomy, and Dr. C. S. Smith, instructor in physiological chemistry.

PROFESSOR H. H. LANE, head of the department of zoology at the University of Oklahoma, has been granted a sabbatical leave of absence on half salary, to carry on research work at Princeton University. Dr. W. C. Allee, formerly instructor in zoology in Williams College, will be acting head of the department, to which he will be permanently attached as assistant professor.

EDWARD J. KUNZE, of the Michigan Agricultural College, has been appointed professor of mechanical engineering in charge of the department of mechanical engineering at the Oklahoma Agricultural and Mechanical College.

DR. ERNEST SACHS, associate in surgery at Washington University Medical School, St. Louis, Mo., has been appointed associate profesor of surgery at the same institution.

F. L. PICKETT, sometime instructor in botany at Indiana University, and for the past year research fellow at the same institution, has been appointed associate professor of plant physiology at Washington State Agricultural College.

JAMES CLARENCE DE VOSS, M.A. (Colorado, '12), has been appointed professor of psychology and education in the Kansas State Normal School at Emporia.

Dr. J. B. Leathes, F.R.S., professor of pathological chemistry in the University of Toronto, has been offered the chair of physiology at the University of Sheffield rendered vacant by the acceptance of Professor J. S. Macdonald of the chair of physiology in the University of Liverpool.

DISCUSSION AND CORRESPONDENCE

RESEARCH ESTABLISHMENTS AND THE UNIVERSITIES

President Woodward's address[1] contains so much of concentrated wisdom on the subject of scientific research within and without universities that no American scientist should fail to read it carefully. The part which impresses me as especially timely deals with "research in academic circles." President Woodward does not discuss the question whether research is a desirable agency in the disciplining of untrained minds, but I understand this to be the theory on which most university instruction in science is now based. The so-called "inductive method" is simply the method of research. Our science courses aim only in a minor degree to impart information; their chief aim is frankly recognized to be training in methods of discovering truth. But is the training of students in *methods* of research itself *research?* This is a subsidiary question which President Woodward's words suggest and concerning which I think we are apt to deceive ourselves.

Our larger universities, and many of our smaller ones too, point with pride to the research work which they are accomplishing. But in not a few cases this work, if inspected carefully, is found to take final shape in dissertations for the doctorate, of doubtful value as contributions to knowledge, prepared primarily not because the author had something of value to record but because he had to record something in order to get the coveted degree.

The chief energies of many professors entirely competent as investigators are wholly absorbed in laboriously dragging candidates through the academic mill up to the final examination for the doctorate. Their success as research professors and the standing of their universities as centers of research is commonly estimated in numbers of doctorates conferred. See the publications of graduate schools, departmental pamphlets, and even Science (Aug. 21, 1914) with its annual list of "Doctorates conferred by American Universities."

Now is this in any true sense *research?* To coach an ambitious but mediocre mind up to the point of making a fair showing for the doctorate is the more exhausting, the more mediocre the candidate. Whatever its educational value, it certainly has little value as research. Yet this makes up a considerable part of the "research" activity of our best universities. Great sums of money are devoted to it in the form of fellowships, scholarships, buildings for laboratories and laboratory equipment for the use of advanced students. A small part of this investment devoted to research by the professors themselves unhampered by a crowd of immature and incompetent students would doubtless be much more effective in advancing knowledge.

The attempt to combine teaching with research has another indirect but evil consequence. The periods which the professor can himself devote to research are intermittent and fragmentary. This affects disadvantageously the topics selected for investigation. They too must be minor and fragmentary. Great fundamental questions requiring long continued and uninterrupted investigation can not be attacked with any hope of success by one who has only an occasional day or a summer vacation to devote to research. The necessity, too, of hunting up thesis subjects for students, small enough in scope to be handled successfully by a beginner in a limited time and yet novel enough to make a showing of originality reacts unfavorably on the professor's own work. It loses both in breadth and depth. He who in the full maturity of his powers should be doing a day's work, runs errands for boys, holds their coats and carries water. Imagine what the "Origin of Species" would have been like had it been brought forward vicariously as a series of theses for the doctor's

[1] "The Needs of Research," Science, August 14, 1914.

degree, each aiming to present a different point of view or a novel method of attacking evolutionary problems. Darwin might in that case have lived to see his pupils holding numerous professorships in widely scattered schools to the glory and delight of his university; the grateful pupils might even have honored him with a Festschrift on forty different and wholly unrelated subjects—but the world would still hold the theory of special creation!

Our universities need carefully to consider whether they are really *fostering research* in multiplying "research courses" in their graduate schools and making larger and larger bids for graduate students. In the interest of genuine research within the universities it is important that they with their estimated hundred millions annual income should not absorb the exclusively research institutions with their paltry two millions estimated annual income. It is important that the latter type of institution should persist, if only to point out the difference between giving all one's time to research and giving all one's time to training for research those who either are incapable of it or are never going to have time for it themselves, but will only repeat the endless process of getting others ready for it.

But it has been objected and will be objected again—If the university does not foster incipient research by training beginners, there will soon be no trained investigators. Is this true? Is it true, I wonder, in the case of astronomy, the oldest of sciences, the one which is almost never used as a stepping stone to the doctorate in a graduate school? Is there a dearth of workers there, of adequately trained and competent ones? Astronomy has certainly not ceased to advance in our time.

Should the university then abandon research? By no means, but it should cease to deceive itself as to what research is. It is not offering "Courses in Research" or conferring doctorates or publishing numerous papers or even building laboratories.

Many of our universities already have attached to them genuine research establishments which are making important contributions to knowledge. As a rule they receive no students and confer no degrees. They are invariably endowed; otherwise they would sooner or later be dragged into the whirlpool of teaching and forced to offer courses and degrees as bait to prospective students and would thus be turned aside from intensive and effective investigation. Some such establishments, however, have other functions which interfere more or less with investigation, such as exhibition and demonstration in museums and gardens.

The university is an entirely suitable place, in many respects the *best* place, for a research establishment; but when such establishments are founded in connection with a university, their purpose *for research* should be made very clear and their administration should be kept very distinct from both teaching and the demonstration of discoveries to the public.

W. E. Castle

August 25, 1914

CHONTAL, SERI AND YUMAN

A recent reexamination of the available evidence bearing on Brinton's old but not generally accepted finding of a genetic relationship between the Chontal (Tequistlatecan), Seri and Yuman Indian languages, confirms his judgment positively. Chontal and Seri being Yuman, are Hokan; and the Hokan family therefore now has a known extent of over 2,000 miles on the Pacific coast of America. So definite are the resemblances furnished by Chontal and Seri that they help to elucidate problems in the Hokan languages of northern California. The results of the study are now awaiting publication.

A. L. Kroeber

September 8, 1914

SCIENTIFIC BOOKS

The Microscopy of Drinking Water. By George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering, Harvard University and Massachusetts Institute of Technology. Third edition, rewritten and enlarged. New York, John Wiley & Sons. 1914. xxi + 405.

The scientific study of the microscopical organisms in their relation to potable waters

(rather than as a source of fish food) is a subject of American origin and development. It was born in the laboratories of the Massachusetts Institute of Technology, nurtured by the Massachusetts State Board of Health and the Boston Water Board, and brought to full maturity in the Mt. Prospect Laboratory of the Water Department of Brooklyn. In Boston and in Brooklyn Professor Whipple was the leading spirit in the investigation of this subject.

His admirable book on the "Microscopy of Drinking Water" was first published in 1899 and has remained the standard text upon this subject. A third edition comprehensively rewritten to include the experience of the last fifteen years is most welcome to all workers in this fascinating and practically important field.

The main objects of the miscroscopical study of water are of course first to determine the causes of odors and turbidities in water and to control the remedial measures applied to them, and second, to work out the relation of the plankton to the life of fishes. It is also of value in certain cases as an index of sewage contamination, as a measure of the processes of self-purification of streams, as an explanation of the sanitary chemical analysis, and as a means of identifying water from particular sources. Professor Whipple is doubtless correct in his conviction that "the micrology of water is going to play an increasingly important part in the science of sanitation."

The methods used for the microscopical examination of water remain essentially as they were worked out by Professor W. T. Sedgwick and Mr. George W. Rafter in 1889. Three important modifications are, however, described by Professor Whipple, the sling filter for examinations in the field, the use of a round cell for counting instead of the expensive and cumbrous oblong one and the use of the cotton disc filter which gives an admirable general idea of the total amount of plankton in a given water. A new chapter on the microscope and its uses by Dr. J. W. M. Bunker is added to the discussion of the specific methods used in water examination.

Professor Whipple's discussion of limnology is extended and amplified in many respects, particularly in regard to the estimation of dissolved gases and their effect upon plankton growth. In general the effect of various environmental conditions upon the multiplication of water organisms is admirably discussed. The diagram of plankton changes in the Genesee River is particularly striking, showing the rise first of bacteria, then of protozoa, then of rotifers and crustacea, as each group preys upon the preceding one. The reviewer must demur at one conclusion, drawn on page 215, to the effect that a curve showing seasonal variations of blue-green algæ and bacteria in Baiseley's Pond, indicates that the former are antagonistic to the latter. It is quite true that the bacteria increase in spring and fall and the cyanophytes in summer; but it seems more probable that the increase in bacteria is merely the usual fall and spring increase due to rains and thaws, which occurs in all surface waters, than that the cyanophytes have anything to do with it. The season of the year has a great many effects upon a great many things and plotting two effects against each other as if they were related has led to many errors.

The most important additions to Professor Whipple's book relate to the practical control of the growths of microscopic organisms and the obnoxious odors and turbidities which they produce. This subject was in its infancy fifteen years ago, but to-day there are three well recognized preventive or remedial procedures, stripping of the reservoir site, treatment with copper sulphate and aeration. Stripping of the reservoir of its organic soil to eliminate the food of the microorganisms has been extensively used in Massachusetts, but the report of Messrs. Hazen and Fuller in connection with the proposed application of this method to the New York water supply (from which Professor Whipple quotes extensively) leads to the conclusion that stripping can not by itself be expected to produce satisfactory results and in most cases involves a large expense of doubtful value. The destruction of the microorganisms by treating reservoir

waters with copper sulphate, Professor Whipple rightly estimates as of great usefulness, although usually as a palliative rather than a permanent remedy. Reliance must be placed in the last resort upon aeration, which changes the odoriferous essential oils produced by the microorganisms into inodorous compounds, combined with filtration for the removal of the organisms themselves. The value of this procedure has been clearly demonstrated both experimentally and on a practical scale, and Professor Whipple describes plants in operation at Rochester and Albany and New York City, and at Springfield, Mass., a view of the Springfield aerating fountain forming a very attractive frontispiece for the volume.

About a quarter of Professor Whipple's book is devoted to a systematic description of the more important genera of water microorganisms. The plates of the first edition have been made much more valuable by being colored, and five new plates have been added, one showing the results of the cotton disc filter test and the other four being photomicrographs of important water organisms. C.-E. A. WINSLOW

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

Essays and Studies Presented to William Ridgeway on his Sixtieth Birthday. Edited by E. C. QUIGGIN. University Press, Cambridge, 1913. Pp. xxv + 656, 93 illustrations.

If a commemoration volume is an index to the scope of the work done by the man it is intended to honor, the Ridgeway volume is indeed a monument to the versatility of the distinguished British scholar. The one drawback about such a work is that only a Ridgeway could adequately review it. There are, for example, 25 papers dealing with classics and archeology—two large but related fields. Then under the head of "Medieval Literature and History" come half a dozen or more important papers.

About half the work is devoted to anthropology and comparative religion. Sample articles under this section include: "The Weeping God," by T. A. Joyce; "The Serpent and the Tree of Life," by J. G. Frazer; "The Problem of the Galley Hill Skeleton," by W. L. H. Duckworth; "The Beginnings of Music," by C. S. Myers; "Kite Fishing," by Henry Balfour, and "The Outrigger Canoes of Torres Straits and North Queensland," by A. C. Haddon.

Lack of space precludes the thought of reviewing the various articles even in a summary fashion. Only two will be selected for this purpose: "The Contact of Peoples," by W. H. R. Rivers, and "The Evolution of the Rock-cut Tomb and the Dolmen," by G. Elliott Smith. As to the contact of peoples Rivers begins with the formulation of the principle that the extent of the influence of one people upon another depends on the difference in the level of their cultures. He tests the principle by applying it to a study of two complex ethnologic problems, viz.: Australian culture and Megalithic monuments. It is shown that Australian culture is not simple, but complex, this complexity being due to many elements derived from without. These elements are supposed to have been introduced at intervals by small bodies of immigrants whose culture seemed so wonderful to the lowly natives that they were able to wield a far-reaching influence, one in fact which was carried by secondary movements throughout the continent. After a time the culture of the immigrants would degenerate, leaving little that was permanent. The traces of these successive influences, however, would live in magical rites, religion, myth, and tradition. This would account for the highly complex social and magico-religious institutions of the Australians, coupled with the extraordinary simplicity and crudeness of their material and even esthetic arts.

The same principle is called into requisition to account for the presence of megalithic monuments in such widely separated parts of the earth. Megalithic culture is thus carried not by vast movements of a conquering people, but by the migration of small bodies of men, the movement being one of culture rather than of race. Such a view is certainly

in keeping with the peculiar distribution of these monuments, their comparative nearness everywhere to the sea.

In "The Evolution of the Rock-cut Tomb and the Dolmen," Elliott Smith would derive the Egyptian *mastaba* from the neolithic grave. He cites Reisner to prove how from the simple trench grave of Predynastic times there was gradually developed a type of tomb consisting of (1) a multichambered subterranean grave, to which a stairway gave access; (2) a brick-work super-structure (mastaba) in the shape of four walls enclosing a mass of earth or rubble; and (3) an enclosure for offerings in front of the brick superstructure. During the period of the Pyramid-builders the mud-brick mastaba began to be imitated in stone. Within the masonry of the mastaba, but near the forecourt, is a narrow chamber, usually known by the Arabic name *Serdab*. Here is placed a statue of the deceased, sometimes also of other members of the family and servants. The statue represents the deceased and is in communication with the outside world through a hole connecting with the forecourt, or chapel. According to Elliott Smith the dolmens scattered over the world from Ireland to Japan are but crude, overgrown and degraded Egyptian mastabas, the one feature retained being the serdab, the dwelling of the spirit of the deceased.

GEORGE GRANT MACCURDY
YALE UNIVERSITY,
NEW HAVEN, CONN.

BOTANICAL NOTES

A NEW NATURE BOOK

WE have had many books on "agriculture" and still more on "nature study," all of which have been more or less helpful, while being at the same time more or less unsatisfactory and it has remained for Professor J. G. Needham to prepare a book which directs the attention of the pupil to both subjects in one view with what appears to be a maximum of helpfulness and a minimum of objectionable features. He calls his book "The Natural History of the Farm" (Comstock Pub. Co., Ithaca, N. Y.) and tells in his preface that it deals with "the sources of agriculture," meaning by this the wild plants, wild animals, the virgin soil, the weather, etc., with which we deal. The idea underlying the treatment is good, and must commend itself to every scientific man. We apprehend that there will be some ultra "practical" critics who will demand more agriculture and less natural history, and yet it has been the writer's observation that just such information as is here given, such suggestions as are here made will prove to be the most helpful to the boys and girls in the country schools. Agriculture is no more all cultivation of crops, than is classical culture simply the study of Greek and Latin roots. This book breathes of the farm and of country life, of the wild things, as well as those that we have brought into our fields and stables. It is an attempt to broaden and liberalize agriculture and to bring it into relation with the things in nature. The topics of some of the chapters will show how this is done: Mother Earth, Wild Fruits of the Farm, Wild Nuts of the Farm, The Farm Stream, Pasture Plants, The Farm Wood-lot, The Wild Mammals of the Farm, The Domesticated Mammals, The Lay of the Land, Winter Activities of Wild Animals, Maple Sap and Sugar, What Goes On in the Apple Blossoms, The Clovers, Weeds of the Field, Some Insects at Work on Farm Crops, etc. Surely no boy or girl in the country could use this book without great pleasure and great profit.

A STUDY OF ASTERS

QUITE recently Charles E. Monroe has published in the *Bulletin* of the Wisconsin Natural History Society a paper on "The Wild Asters of Wisconsin," which is of more than the usual interest of local lists, or local discussions of groups of species. In his introduction the author makes some thoughtful suggestions as to "species" in general, and "species" of asters in particular. Thus he says

> The old notion of a species, as something definite, fixed and stable, nowhere breaks down more completely than when an attempt is made to apply it to the different forms of *Aster* as we find them in this country. Different species are so connected by intermediate forms that we often feel like ignoring specific distinctions and grouping two or

more species together under one name. On the other hand, to one of a more analytical bent of mind, the difference between members of a single species may appear so marked that he will be under constant temptation to separate them into still smaller subdivisions and to give to each specific rank. But, whichever course we follow, the different groups into which the genus, or a species, may be divided represent little more than particular tendencies or directions of variation, and the members of each make up a series illustrating the different stages. The word "species," as applied to our North American asters, can hardly be said to have any other significance than this.

It will startle some old-fashioned taxonomists to read the next sentence:

It does not seem a valid objection that under such a definition a single plant might be conceived as belonging to more than one species.

Notes are made of ten previous lists of Wisconsin asters, and then follows a systematic and critical discussion of the species recognized by the author. This latter is so well done that one is tempted to wish that it might be used as a model by other local botanists.

SHORT NOTES

IMPORTANT phytopathological papers by G. G. Hedgcock have appeared as follows: "Notes on Some Western Uredineae which attack Forest Trees" (*Phytopath.*, III.); "Notes on Some Diseases of Trees in our National Forests" (*Phytopath.*, III.); "Injury by Smelter Smoke in Southeastern Tennessee" (*Jour. Wash. Ac. Sci.*, IV.); "The Alternate Stage of *Peridermium pyriforme*" (privately printed June 12, 1914). In the latter the conclusion is reached that the alternate stage occurs on *Comandra umbellata*.

B. F. LUTMAN contributes an interesting paper on "The Pathological Anatomy of Potato Scab" accompanied with ten text figures, in which he concludes that "The scab is due to the hypertrophy of the cells of the cork cambium" (*Phytopath.*, III.). The same author's "Studies on Club-root" (Bull. 175, Vt. Agr'l Expt. Sta.) will be suggestive to those who are interested in the organisms usually known as slime molds (Myxomycetes). The one here under consideration is *Plasmodiophora brassicae*, and it infests the root cells of cabbages and other cruciferous plants. It gains entrance either through the epidermis or the root-hairs, and produces cellular hypertrophy, especially of the cortical tissues.

Nuclear divisions in the plasmodium are of two types—vegetative and reduction. The vegetative divisions are peculiar in that a spireme is not formed. . . . The reduction division is one of those preceding spore formation, probably the first.

Six text figures and four plates (with 52 figures) accompany the twenty-seven pages of text.

A SIGNIFICANT feature of the new edition of the "Genera of British Plants," by H. G. Carter (Cambridge, 1913), is the adoption of Engler's system. At the outset it must be remembered that the "plants" referred to in the title are the ferns and flowering plants. The little book (of 139 pages)

is intended to familiarize students of British vascular plants with Engler's system in its latest form, and thus to habituate British floristic students to the use of a more natural system than that to which they have been accustomed in the British floras that have hitherto appeared.

In carrying out this plan the class, ordinal and family characters are clearly given, while the genera are briefly characterized by means of analytic keys. A similar book for North America would be very useful. However, we can not approve of the use of the terms "apopetalous" and "apochlamydeous" as defined by the author (petals, or perianth "absent by reduction") even though sanctioned by Engler. Certainly "apetalous" and "achlamydeous" are sufficiently definite for the conditions of *no petals*, and *no perianth*, leaving "apopetalous," and "apochlamydeous" for the conditions of *separate petals*, and *separate perianth segments*.

CHARLES E. BESSEY

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SPECIAL ARTICLES

THE ALLEGED DANGERS TO THE EYE FROM ULTRA-VIOLET RADIATION

DURING recent years there have been not a few sensational attacks upon modern illu-

minants as dangerous by reason of injurious effects of the ultra-violet radiation delivered by them. The literature of the subject is large, but unhappily most of the investigations have entirely neglected any quantitative relation between the radiation and its supposed pathological effects. One can not stigmatize an illuminant which emits ultra-violet as dangerous for this reason any more than one can declare a stove unfit for use because it is possible to burn the finger by deliberately touching it. The vital question is not whether a light source gives ultra-violet radiations, but whether it gives them of such kind, and in sufficient quantity, as to make any injury to the eye possible under practical conditions. A second point frequently neglected in the discussion of this subject has been the action of the eye itself in focusing radiation falling upon it, with the resulting effects upon the intensity of the radiation in the media of the eye. Finally a great many errors have been made and unwarrantable conclusions reached owing to the fact that in the solar spectrum the maximum intensity of radiation is in the brilliantly luminous part of the spectrum, where in addition the so-called actinic power is considerable, so that phenomena possibly having their origin in specific effects of radiation of particular wave-length become difficult to separate from those of purely thermic origin.

During more than two years past the writers have spent a large amount of their time in an investigation from a quantitative standpoint of the effects of radiation on the various media of the eye from the corneal epithelium back to the retina, and have investigated with considerable care the maladies reputed by one writer or another to be due to the specific effects of radiation. Broadly we have found that no artificial source of light used for illuminating purposes contains enough ultra-violet radiation to involve the slightest danger to the eye from its effects under any readily conceivable conditions of use, and that such pathological action as can be obtained experimentally from the ultra-violet is confined to a strictly limited region of the spectrum and obeys perfectly definite quantitative laws in its action. Incidentally we have found most extraordinary resisting power of the eye as respects radiations outside this particular range, which is in fact the whole body of radiation present in any material quantity in the energy normally received from the sun at the surface of the earth.

Our conclusions regarding these fundamental matters and respecting the various alleged pathological effects which have been charged up against radiation are appended as preliminary to the more complete publication of the methods and results of our investigations. Most of the experiments were made upon the eyes of rabbits and monkeys. An especially noteworthy experiment, however, relating to the possibility of abiotic action on the retina, was made upon a human patient affected with cancer of the eye-lids, twenty-four hours before the eye was removed. A number of crucial experiments were also made upon our own eyes. It should be especially noted that while the abiotic effects of the extreme ultra-violet on the outer eye are well defined, they are limited to a particular region and their extent in case of exposure to any given radiant can be definitely predicted and effectively guarded against.

Conclusions

The liminal exposure capable of producing photophthalmia to the extent of conjunctivitis accompanied by stippling of the cornea, is in terms of energy 2×10^6 erg seconds per square cm. of abiotic radiation of the character derived, for example, from the quartz lamp or the magnetite arc. About two and a half times this exposure, *i. e.*, 5×10^6 erg seconds per square cm., is required to produce loss of corneal epithelium.

The abiotic action on the cornea and conjunctiva produced by any radiating source follows the law of inverse squares and is directly proportional to the total abiotic energy received. It can therefore be definitely predicted from the physical properties of the source.

After exposure of the eye to abiotic radiations there is a latent period before any effects,

clinical or histological, become perceptible. This period of latency in a general way varies inversely with the severity of the exposure, but a theoretical latency of 24 hours or more corresponds to an exposure entirely subliminal.

The combined effect of repeated exposures to abiotic radiations is equivalent to that of a continuous exposure of the same total length, provided the intermissions are not long enough to establish reparative effects. Approximately, the exposures are additive for intermissions of somewhat less than 24 hours. Exposures of one third the liminal given daily begin to show perceptible effect only after about six exposures. Daily exposures of one sixth the liminal repeated over long periods produce no effect whatever, except to give the external eye a degree of immunity against severer exposures. Actual abiotic damage to the external eye renders it temporarily more sensitive to abiotic action.

Abiotic action for living tissues is confined to wave-lengths shorter than 305 $\mu\mu$, at which length abiotic effects are evanescent, while for shorter wave-lengths they increase with considerable rapidity.

For the quartz arc and the magnetite arc the abiotic activity of the rays absorbed by the cornea is eighteen times greater than those which are transmitted by it. To effect the media back of the cornea requires, therefore, at least eighteen times the liminal exposure heretofore mentioned.

Even with exposures as great as one hundred and fifty times the liminal for photophthalmia the lens substance is affected to a depth of less than 20 μ, and this superficial effect undergoes in the rabbit complete repair. Such enormously intensive exposures, which we obtain with the magnetite arc and double quartz lens system may completely destroy the corneal epithelium, corpuscles and endothelium. The corneal stroma may be strongly affected by waves shorter than 295 $\mu\mu$, which it completely absorbs, but is very slightly affected by the remaining abiotic radiation.

The histological changes produced by abiotic radiation are radically different from those produced by heat, and the cell changes are best seen in flat preparations of the lens capsule. The most characteristic change is the breaking up of the cytoplasm into eosinophilic and basophilic granules.

Changes in the lens epithelium like those following abiotic action, including the formation of a "wall" beneath the pupillary margin, are not exclusively characteristic of abiotic action, but may be produced by ordinary chemical reagents. They are, therefore, characteristic not of abiotic action alone, but of chemical action in general.

Abiotic radiations certainly do not directly stimulate, but, on the contrary apparently depress mitosis. Their action in this respect also is materially different from that of heat.

The lens protects completely the retina of the normal eye even from the small proportion of feebly abiotic rays which can penetrate the cornea and vitreous.

Experiments on rabbits, monkeys and the human subject prove that the retina may be flooded for an hour or more with light of extreme intensity (not less than 50,000 lux), without any sign of permanent injury. The resulting scotoma disappears within a few hours. Only when the concentration of light involves enough heat energy to produce definite thermic lesions is the retina likely to be injured.

The retina of the aphakic eye, owing to the specific and general absorption of abiotic radiations by the cornea and the vitreous body, is adequately protected from injury from any exposures possible under the ordinary conditions of life, even without the added protection of the glasses necessary for aphakic patients.

To injure the cornea, iris, or lens, by the thermic effects of radiation, requires a concentration of energy obtainable only under extreme experimental conditions.

Infra-red rays have no specific action on the tissues analogous to that of abiotic rays. Any effect due to them is simply a matter of thermic action, and such rays are in the main absorbed by the media of the eye before reaching the retina.

Actual experiments made on the human eye

show conclusively that no concentration of radiation on the retina from any artificial illuminant is sufficient to produce injury thereto under any practical conditions.

Eclipse blindness, the only thermic effect on the retina of common occurrence clinically, is due to the action of the concentrated heat on the pigment epithelium and chorioid, this heat being almost wholly due to radiations of the visible spectrum, within which the maximum solar energy lies.

The abiotic energy in the solar spectrum is a meager remnant between wave-lengths 295 $\mu\mu$ and 305 $\mu\mu$, aggregating hardly a quarter of one per cent. of the total. At high altitudes and in clear air it is sufficient to produce slight abiotic effects such as are noted in snow blindness and solar erythema, the former only occurring with long exposures under very favorable circumstances and the latter being in ordinary cases complicated by an erythema due to heat alone. The amount of abiotic energy required to produce a specific effect in solar erythema is substantially the same as that required for mild photophthalmia.

Erythropsia is not in any way connected with the exposure of the eye to ultra-violet radiations, but is merely a special case of color fatigue temporary and without pathological significance.

Vernal catarrh and senile cataract we can find no evidence for considering as due to radiations of any kind.

Glass blowers' cataract, often charged to specific radiation, ultra-violet or other, we regard as probably due to the overheating of the eye as a whole with consequent disturbed nutrition of the lens.

Commercial illuminants we find to be entirely free of danger under the ordinary conditions of their use. The abiotic radiations, furnished by even the most powerful of them, are too small in amount to produce danger of photophthalmia under ordinary working conditions even when accidentally used without their globes. The glass enclosing globes used with all practical commercial illuminants are amply sufficient to reduce any abiotic radiations very far below the danger point.

Under ordinary conditions no glasses of any kind are required as protection against abiotic radiations. The chief usefulness of protective glasses lies not so much in their absorption of any specific radiations, as in their reducing the total amount of light to a point where it ceases to be psychologically disagreeable or to be inconveniently dazzling. Glasses which cut off both ends of the spectrum and transmit chiefly only rays of relatively high luminosity, give the maximum visibility with the minimum reception of energy. For protection against abiotic action in experimentation, or in the snow fields, ordinary colored glasses are quite sufficient.

So far as direct destruction of bacteria within the cornea or any other tissues of the body is concerned, abiotic radiations possess no therapeutic value. This is due to the fact that abiotic radiations that are able to penetrate the tissues are more destructive to the latter than to bacteria.

F. H. Verhoeff,
Louis Bell

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

By invitation of Brown University, the twenty-first summer meeting of the society was held at that institution on Tuesday and Wednesday, September 8–9, in connection with the celebration of the one hundred and fiftieth anniversary of the founding of the university. Two sessions were held on Tuesday and a morning session on Wednesday, the attendance including fifty-two members. President Van Vleck occupied the chair at the morning sessions, being relieved by Vice-president L. P. Eisenhart at the Tuesday afternoon session. New members were elected as follows: Mr. L. K. Adkins, University of Minnesota; Dr. Lennie P. Copeland, Wellesley College; Mr. J. W. Cromwell, Jr., Washington, D. C., High Schools; Professor Tsuruichi Hayashi, Tôhoku Imperial University, Sendai, Japan; Professor C. I. Palmer, Armour Institute of Technology; Mr. G. A. Pfeiffer, Columbia University; Mr. P. R. Rider, Yale University; Dr. Alfred Rosenblatt, University of Cracow; Miss Caroline E. Seely, Columbia University. Eleven applications for membership were received. It was decided to hold the annual meeting about January 1, the exact date to be so fixed that those who wish

may attend the winter meeting of the Chicago Section and the meeting of Section A of the American Association, as well as the annual meeting. At the latter meeting, which will be held in New York, President Van Vleck will deliver his presidential address.

A committee was appointed to arrange for holding the summer meeting of 1915 at San Francisco. It was decided to issue only the List of Officers and Members next year, in place of the usual Annual Register.

The authorities of Brown University extended a lavish hospitality to the society. The morning session on Tuesday opened with an address of welcome by Chancellor A. B. Chace. Professor N. F. Davis entertained the members and ladies at tea in the John Carter Brown Library on Tuesday afternoon, and at luncheon in Rockefeller Hall on Wednesday. The university gave a dinner in honor of the society at the University Club on Tuesday evening, the occasion concluding with a cordial address by President Faunce and an interesting account by Professor Carl Barus of the "Historical development of the modern theory of physics." A vote of thanks was tendered to the university and its officers for their generous hospitality. Wednesday afternoon was devoted to an excursion to Newport.

The following papers were read at this meeting:

F. M. Morgan: "A plane cubic Cremona transformation and its inverse."

L. P. Eisenhart: "Conjugate systems with equal tangential invariants and the transformation of Moutard."

C. E. Love: "Singular integral equations of the Volterra type."

O. E. Glenn: "Modular invariant processes."

L. E. Dickson: "Invariants, seminvariants and covariants of the ternary and quaternary quadratic form modulo 2."

L. E. Dickson: "The points of inflection of a plane cubic curve."

L. E. Dickson: "A fundamental set of modular invariants of the system of the binary cubic, quadratic and linear form."

L. E. Dickson: "Invariants in the theory of numbers."

F. B. Wiley: "Proof of the finiteness of the modular covariants of a system of binary forms and cogredient points."

E. V. Huntington: "The theorem of rotation in elementary dynamics."

R. D. Beetle: "Congruences associated with a one-parameter family of curves."

G. C. Evans: "The non-homogeneous parabolic differential equation."

R. A. Johnson: "The conic as a space element."

W. A. Hurwitz and L. L. Silverman: "On the consistency and equivalence of certain definitions of summability."

Maxime Bôcher: "The method of successive approximations for linear differential systems."

Maxime Bôcher: "The smallest characteristic numbers in a certain exceptional case."

B. H. Camp: "On the series obtained by termwise integration."

G. A. Miller: "On the ϕ-subgroup of a group."

T. E. Mason: "On functions transcendentally transcendental with respect to a given realm of rationality."

T. E. Mason: "Mechanical device for testing Mersenne numbers for primes."

H. S. Vandiver: "On Bernoulli's numbers, Fermat's quotient and last theorem."

L. C. Karpinski: "An early algorism."

H. S. White: "Triple systems on 31 letters; a reconnoissance."

L. D. Cummings: "The trains for 42 non-congruent triple-systems on 15 elements."

J. H. M. Wedderburn: "On matrices whose coefficients are entire functions."

E. R. Smith: "A problem in the fitting of polynomial curves to certain kinds of data."

H. R. Kingston: "Metric properties of nets of plane curves"

G. D. Birkhoff: "The iterated transformation of a plane into itself."

W. B. Fite: "Prime power groups in which every commutator of prime order is invariant."

Edward Kasner: "Transversality for double integrals in the calculus of variations and for contact transformations."

Edward Kasner: "The decomposition of conformal transformations into factors of period two."

R. G. D. Richardson: "A new boundary value problem for linear hyperbolic differential equations of the second order."

Joseph Rosenbaum: "Mixed linear integral equations over a two-dimensional region."

D. C. Gillespie: "Cauchy's definition of a definite integral."

The next regular meeting of the society will be held at Columbia University on October 31. The San Francisco Section will meet at the University on October 24.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, OCTOBER 2, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT TO THE SECTION OF MATHEMATICAL AND PHYSICAL SCIENCE OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

WE have lost since the last meeting of the section several distinguished members who have in the past added so much to the usefulness of our discussions. These include Sir Robert Ball, who was one of our oldest attendants, and was president of the section at the Manchester meeting in 1886; Professor Poynting, who was President of the Section at Dover in 1899, and Sir David Gill, who was President of the Association at Leicester in 1907.

It seems appropriate at this meeting in the city of Melbourne to mention one who passed away from his scientific labors somewhat previous to the last meeting. I allude to W. Sutherland, of this city, whose writings have thrown so much light on molecular physics and whose scientific perspicacity was only equaled by his modesty.

This meeting of the British Association will be a memorable one as being indicative, as it were, of the scientific coming of age of Australia. Not that the maturity of Australian science was unknown to those best able to judge, indeed the fact could not but be known abroad, for in England alone there are many workers in science hailing from Australia and New Zealand, who have enhanced science with their investigations and who hold many important scientific posts in that country. In short, one finds it best nowadays to ask of any young investigator if he comes from the Antipodes.

[1] Section A: Australia, 1914.

This speaks well for the universities and their staffs, who have so successfully set the example of scientific investigation to their pupils.

Radioactivity and kindred phenomena seem to have attracted them most of late years, and it would perhaps have been appropriate to have shortly reviewed in this address our knowledge in these subjects, to which the sons of Australasia have so largely contributed.

Twenty-five years ago FitzGerald and others were speculating on the possibility of unlocking and utilizing the internal energy of the atom. Then came the epoch-making discovery of Becquerel, to be followed by the brilliant work of Rutherford and others showing us that no key was required to unlock this energy; the door lay open.

We have still facing us the analogous case of a hitherto untapped source of energy arising from our motion through the ether. All attempts, it is true, to realize this have failed, but nevertheless he would be a brave prophet who would deny the possibility of tapping this energy despite the ingenious theories of relativity which have been put forward to explain matters away. There is no doubt but that up to the present nothing hopeful has been accomplished towards reaching this energy and there are grave difficulties in the way; but "Relativity" is, as it were, merely trying to remove the lion in the path by laying down the general proposition that the existence of lions is an impossibility. The readiness with which the fundamental hypotheses of "Relativity" were accepted by many is characteristic of present-day physics, or perhaps, more correctly speaking, is an exaggerated example of it.

Such an acceptance as this could hardly be thought of as taking place half a century ago when a purely dynamical basis was expected for the full explanation of all phenomena, and when facts were only held to be completely understood if amenable to such treatment; while, if not so, they were put temporarily into a kind of suspense acount, waiting the time when the phenomenon would succumb to treatment based on dynamics.

Many things, perhaps not the least among them radio-activity, have conspired to change all this and to produce an attitude of mind prepared to be content with a much less rigid basis than would have been required by the natural philosophers of a past generation. These were the sturdy protestants of science, to use an analogy, while we of the present day are much more catholic in our scientific beliefs, and in fact it would seem that nowadays to be used to anything is synonymous with understanding it.

Leaving, however, these interesting questions, I will confine my remarks to a rather neglected corner of physics, namely, to the phenomena of absorption and adsorption of solutions. The term adsorption was introduced to distinguish between absorption which takes place throughout the mass of the absorbing material and those cases in which it takes place only over its surface. If, for instance, glass, powdered so as to provide a large surface, is introduced into a solution of a salt in water, we have in general some of the salt leaving the body of the solution and adhering in one form or other to the surface of the glass. It is to this the term adsorption has been applied. Physicists have now begun to take up the question seriously, but it was to biologists and especially physiological chemists that most of our knowledge of the subject in the past was due, the phenomenon being particularly attractive to them, seeing that so many of the processes they are interested in take place across surfaces.

As far as investigations already made go, the laws of adsorption appear to be very complicated, and no doubt many of the conflicting experimental results which have been obtained are in part due to this, workers under somewhat different conditions obtaining apparently contradictory effects.

On the whole, however, it may be said that the amount adsorbed increases with the strength of solution according to a simple power law, and diminishes with rise of temperature; but there are many exceptions to these simple rules. For instance, in the case of certain sulphates and nitrates the amount adsorbed by the surface of, say, precipitated silica, only increases up to a certain critical point as the strength of the solution is increased. Then further increase in the strength of the solution causes the surface to give up some of the salt it has already adsorbed or the amount adsorbed is actually less now than that adsorbed from weaker solutions. Beyond this stage for still greater concentrations of the solutions the amount adsorbed goes on increasing as before the critical point was reached.

There is some reason for thinking that there are two modes in which the salt is taken up or adsorbed by the solid surface. The first of them results from a simple strengthening of the solution in the surface layers; the second, which takes place with rather stronger concentrations, is a deposition in what is apparently analogous to the solid form. It would seem that the first reaches out from the solid surface to about 10^{-8} cm.—which is the order of the range of attraction of the particles of the solid substance.

The cause of the diminution in the adsorption layer at a certain critical value of the concentration is difficult to understand. Something analogous has been observed by Lord Rayleigh in the thickness of layers of oil floating on the surface of water. As oil is supplied the thickness goes on increasing up to a certain point, beyond this, on further addition of oil, the layer thins itself at some places and becomes much thicker at others, intermediate thicknesses to these being apparently unstable and unable to exist. As helping towards an explanation of the diminution in the adsorption layer we may suppose that as the strength of the solution is increased from zero, the adsorption is at first merely an increased density of the solution in the surface layer. For some reason, after this has reached a certain limit, further addition of salt to the solution renders this mode of composition of the surface layers unstable, and there is a breaking up of the arrangement of the layer with a diminution in its amount. We may now suppose the second mode of deposition to begin to show its effect with a recovery in the amount of the surface layers and a further building up of the adsorption deposits.

On account of passing through this point of instability the process is irreversible, so that the application of thermo-dynamics to the phenomenon of adsorption is necessarily greatly restricted in its usefulness.

A possible cause of the instability in the adsorption layer which occurs at the critical point may be looked for in the alternations in the sign of the mutual forces between attracting particles of the kind suggested by Lord Kelvin and others. Within a certain distance apart—the molecular range—the particles of matter mutually attract one another, while at very close distances they obviously must repel, for two particles refuse to occupy the same space. At some intermediate distances the force must pass through zero value. It has for various reasons been thought that, in

addition, the force has zero value at a second distance lying between the first zero and the molecular range, with accompanying alternations in the sign of the force. Thus, starting from zero distance apart of the particles, the sign of the force is negative or repulsive; then, as the distance apart is supposed to increase, the force of repulsion diminishes, and after passing through zero value becomes positive or attractive; next, as the distance is increased the force diminishes again, and after passing through a second zero becomes negative for a second time; finally, the force on passing through a third zero becomes positive, and is then in the stage dealt with in capillary and other questions.

As an instance, of where these alternations of sign seem to be manifest, may be mentioned the case of certain crystals when split along cleavage planes. The split often runs along further than the position of the splitting instrument or inserted wedge seems to warrant. This would occur if the particles on either side of the cleavage plane were situated at the distance apart where the force between them was in the first attractive condition, for then on increasing the distance between the particles by means of the wedge the force changes sign and becomes repulsive, thus helping the splitting to be propagated further out.

Assuming that a repulsive force can supervene between the particles in the adsorption layer, through the particles becoming so crowded in places as to reduce their mutual distances to the stage when repulsion sets in, we might expect that an instability would be set up.

As already stated, a rise in temperature reduces in general the amount adsorbed, but below the critical point the nitrates and sulphates are exceptional, for rise in temperature here increases the amount adsorbed from a given solution. This obviously necessitates that the isothermals cross one another at the critical point in an adsorption-concentration diagram. This may perhaps account for some observers finding that adsorption did not change with temperature. We have another exception to the simple laws of adsorption in the case of the alkali chlorides; this exception occurs under certain conditions of temperature and strength of solution. The normal condensation into the surface layer is reversed and the salt is repelled into the general solution instead of being attracted by the surface. In other words, it is the turn of the other constituent of the solution, namely, the water, to be adsorbed.

It is a very well known experiment in adsorption to run a solution such as that of permanganate of potash through a filter of sand, or, better, one of precipitated silica, so as to provide a very large surface. The first of the solution to come through the filter has practically lost all its salt, owing to having been adsorbed by the surface of the sand.

I was interested in finding a few months ago that Defoe, the author of "Robinson Crusoe," in one of his other books, depicts a party of African travelers as being saved from thirst in a place where the water was charged with alkali by filtering the water through bags of sand. Whether this is a practical thing or not is doubtful, or even if it has ever been tried; for it is only the first part of the liquid to come through the filter which is purified, and very soon the surface has taken up all the salt it can adsorb, and after that, of course, the solution comes through intact. It is interesting, however, to know that so long ago as Defoe's time the phenomenon of adsorption from salt solutions had been observed. It is not so well known that in the case of

some salts under the circumstances mentioned above, the first of the solution to come through the sand filter is stronger instead of weaker. This, as already mentioned, is because water, or at least a weaker solution, forms the adsorption layer.

Most of the alkali chlorides as the temperature is raised show this anomalous adsorption, provided the strength of the solution is below a certain critical value differing for each temperature. For strengths of solution above these values the normal phenomenon takes place.

No investigations seem to have been made on the effect of pressure on adsorption. These data are much to be desired.

The investigation of adsorption and absorption should throw light on osmosis, as in the first place the phenomenon occurs across a surface necessarily covered with an adsorption layer, and in the second place, as we shall see, the final condition is an equilibrium between the absorption of water by the solution and that by the membrane.

The study of the conditions of absorption of water throughout the mass of the colloidal substance of which osmotic membranes are made is of much interest. Little work has been done on the subject as yet, but what little has been done is very promising.

It is convenient to call the material of which a semi-permeable membrane is made the semi-permeable medium. The ideal semi-permeable medium will not absorb any salt from the solution, but only water, but such perfection is probably seldom to be met with. If a semi-permeable medium such as parchment paper be immersed in a solution, say, of sugar, less water is taken up or absorbed than is the case when the immersion is in pure water. The diminution in the amount absorbed is found to increase with the strength of the solution. It is at the same time found that the absorption or release of water by the semi-permeable medium according as the solution is made weaker or stronger is accompanied by a swelling or shrinkage greater than can be accounted for by the water taken up or rejected.

The amount of water absorbed by a semi-permeable medium from a solution is found by experiment to depend upon the hydrostatic pressure. If the pressure be increased the amount of water absorbed by the semi-permeable medium is increased. It is always thus possible by the application of pressure to force the semi-permeable medium to take up from a given solution as much water as it takes up from pure water at atmospheric pressure.

It is not possible for a mass of such a medium to be simultaneously in contact and in equilibrium with both pure water and with a solution all at one and the same pressure, seeing that the part of the medium in contact with the pure water would hold more water than that part in contact with the solution, and consequently diffusion would take place through the mass of the medium.

If, however, the medium be arranged so as to separate the solution and the water and provided the medium is capable of standing the necessary strain, it is possible to increase the pressure of the solution without increasing the pressure of the water on the other side. Thus the part of the medium which is in contact with the solution is at a higher pressure than that part in contact with the pure solvent; consequently the medium can be in equilibrium with both the solution and the solvent, for if the pressures are rightly adjusted the moisture throughout the medium is everywhere the same.

The ordinary arrangement for showing

osmotic pressure is a case such as we are considering, and equilibrium throughout the membrane is only obtained when the necessary difference in pressure exists between the two sides of the membrane.

This condition would eventually be reached no matter how thick the membrane was. It is sometimes helpful to think of the membrane as being very thick. It precludes any temptation to view molecules as shooting across from one liquid to the other through some kind of peepholes in the membrane.

The advantage in a thin membrane in practise is simply that the necessary moisture is rapidly applied to the active surface, thus enabling the pressure on the side of the solution to rise quickly, but it has no effect on the ultimate equilibrium.

As far as that goes, the semi-permeable membrane or saturated medium might be infinitely thick, or, in other words, there need be no receptacle or place for holding the pure solvent outside the membrane at all. In fact, the function of the receptacle containing the pure solvent is only to keep the medium moist, and is no more or no less important than the vessel of water supplied to the gauze of the wet-bulb thermometer. It is merely to keep up the supply of water to the medium.

The real field where the phenomenon of osmosis takes place is the surface of separation between the saturated semi-permeable medium and the solution. Imagine a large mass of colloidal substance saturated with water and having a cavity containing a solution. The pressure will now tend to rise in the cavity until it reaches the osmotic pressure—that is, until there is established an equilibrium of surface transfer of molecules from the solution into the medium and back from the medium into the solution.

No doubt, the phenomenon as thus described occurs often in nature. It is just possible that the high-pressure liquid cavities, which mineralogists find in certain rock crystals, have been formed in some such manner in the midst of a mass of semi-permeable medium; the pure solvent in this case being carbon dioxide and the medium colloidal silica, which has since changed into quartz crystal.

In considering equilibrium between a saturated semi-permeable medium and a solution there seems to me to be a point which should be carefully considered before being neglected in any complete theory. That is, the adsorption layer over the surface of the semi-permeable medium. We have seen that solutions are profoundly modified in the surface layers adjoining certain solids, through concentration or otherwise of the salts in the surface layer, so that the actual equilibrium of surface transfer of water molecules is not between the unmodified solution and the semi-permeable medium, but between the altered solution in the absorption layer and the saturated medium. Actual determinations of the adsorption by colloids are much wanted, so as to be able to be quite sure of what this correction amounts to or even if it exists. It may turn out to be zero. If there is adsorption, however, it may possibly help to account for part of the unexpectedly high values of the osmotic pressure observed at high concentrations of the solution, the equilibrium being, as we have seen, between the saturated medium and a solution of greater concentration than the bulk of the liquid, namely, that of the adsorption layer. In addition, when above the critical adsorption point, there may be a deposit in the solid state. This may produce a kind of polarized equilibrium of surface transfer in which the molecules which discharge from the saturated medium remain unaltered in amount, but those

which move back from the adsorption layer are reduced owing to this deposit, thus necessitating an increase in pressure for equilibrium. If either or both of these effects really exist, it would seem to require that the pressure should be higher for equilibrium of the molecular surface transfer than if there were no adsorption layer and the unaltered solution were to touch the medium, but at the same time it should be remembered that there is a second surface where equilibrium must also exist—that is, the surface of separation of the adsorption layer and the solution itself. It is just possible that the two together cancel each other's action.

Quantitative determinations of adsorption by solid media from solution are hard to carry out, but with a liquid medium it is not so difficult. Ether constitutes an excellent semi-permeable medium for use with sugar solution, because it takes up or dissolves only a small quantity of water and no sugar. A series of experiments using these for medium and solution has shown (1) that the absorption of water from a solution diminishes with the strength of the solution; and (2) that the absorption of water for any given strength of solution increases with the pressure. This increase with pressure is somewhat more rapid than if it were in proportion to the pressure. On the other hand, from pure water ether absorbs in excess of normal almost in proportion to the pressure. Certainly this is so up to 100 atmospheres. This would go to confirm the suggestion already made that the departure from proportionality in the osmotic pressure is attributable to absorption.

By applying pressure ether can be thus made to take up the same quantity of water from any given solution as it takes up from pure water at atmospheric pressure. It is found by experiment that this pressure is the osmotic pressure proper to the solution in question.

Decidedly the most interesting fact connected with the whole question of osmotic pressure, the behavior of vapor pressures from solution, and the equilibrium of molecular transfer of solutions with colloids, is that discovered by Van't Hoff, that the hydrostatic pressure in question is equal to what would be produced by a gas having the same number of particles as those of the introduced salt. Take the case of a mass of colloid or semi-permeable medium placed in a vessel of water; the colloid when in equilibrium at atmospheric pressure holds what we will call the normal moisture. By increasing the pressure this moisture can be increased to any desired amount. Now, on introducing salt the moisture in the colloid can be reduced at will. The question is, what quantity of salt must be introduced just to bring back the amount of the moisture in the colloid to normal? Here we get a great insight into the internal mechanism of the liquid state. The quantity of salt required turns out to be, approximately at least, that amount which if in the gaseous state would produce the pressure. So that normality can be either directly restored by removing the pressure or indirectly by introducing salt in quantity which just takes up the applied pressure. That this is so naturally suggested that the salt, although compelled to remain within the confines of the liquid, nevertheless produces the same molecular bombardment as it would were it in the gaseous state, though of course the free path must be viewed as enormously restricted compared with that in the gaseous state.

Many have felt a difficulty in accepting this view of a molecular bombardment occurring in the liquid state, but of recent years much light has been thrown on the subject of molecular movements in liquids,

especially by Perrin's work, so that much of the basis of this difficulty may be fairly considered as now removed.

Quite analogous to the reduction from the normal of the moisture held by a semi-permeable medium brought about by the addition of salt to the water, is the reduction in the vapor pressure arising from the presence of a salt in the water. The vapor pressure is likewise increased by the application of hydrostatic pressure, which may be effected by means of an inert gas. In both cases the hydrostatic pressure which must be applied to bring back to normality is equal to that which the added salt would exert if it were in the state of vapor or, in other words, the osmotic pressure.

The two cases are really very similar. In both there is equal molecular transfer backwards and forwards across the bounding surface. In the one a transfer from that solution to the semi-permeable medium and back from it into the solution. In the other a transfer from the solution into the superambient vapor and back from it into the solution.

The processes are very similar, namely, equal molecular transfer to and fro across the respective surfaces of separation.

Thus we may in the case of osmotic equilibrium attribute the phenomenon with Callender to evaporation, but not evaporation in its restricted sense, from a free surface of liquid, but as we have seen from a saturated colloidal surface into the solution. This process might perhaps be better referred to as molecular emigration, the term migration being already a familiar one in connection with liquid phenomena.

F. T. Trouton

THE SPIRIT OF A UNIVERSITY

A decade ago in the United States of America, in a university rated among the first in numbers of students, the professor of astronomy was summoned before the president and the governing board and asked whether he believed the nebular hypothesis which he discussed in a text-book issued under his name. An answer in the affirmative was promised to cost him his teaching position. He answered in the negative, and to prove his sincerity assented to calling in his books and having them burned in public. A less number of years ago a university president whom we to-day honor as a first citizen found it well, or shall we say necessary, to step out of his chosen field of work because he held the minority view among his associates that the word democracy does not mean a political party only. Some months ago a professor of philosophy, teaching its principles as he saw them and under a freedom apparently guaranteed him by charter, alleges his resignation is requested because such teaching in the mind of his president is incompatible with the doctrinal views of an avowedly religious organization operating in some state or states of our Union.

Again, the members of a faculty wake to their accustomed labors and over the coffee and in the newspaper receive first word that their places have over night been declared vacant; a university president demands that his faculty vote Yes or No as an expression of their confidence in him; a faculty member backed by brains and fearlessness rises to condemn most of those time-sanctified institutions of boards of control and university presidents.

It is well to emphasize that these illustrations do not represent hand-picked rarities, but are typical of a class of problems which in greater or less degree arise periodically to clog the machinery of university education. Neither can it be said that a correct solution is not usually found for them. The only question of importance is why the delay in so doing and why so much

of heart burning in the process. The perspective of time answers ever the same—some of those involved, and they may be trustees, presidents, faculty members, or the public at large, have never learned or have temporarily forgotten what constitutes a university.

And what does constitute a university? Time again writes: *It is a collection of men at work solving the problems that our universe presents and standing ready to teach to others the methods of such analysis.*

This definition will doubtless strike many a reader as strangely incomplete. As a first omission will be felt the ignoring of its legal status which in our modern day plays so large a part in the constitution of the university. To understand properly the national, state or municipal aspects of a university we must go back to the original charters granted the original institutions, when we will see in them nothing but the sovereign guarantee of special protection to the workers which constitute the university. The reasons for the necessity of such special protection we shall discuss shortly; but here it is well to ponder for a moment the mere fact. It can hardly be said that such protection of the men of our faculties in America has ever made itself apparent. There are plenty of illustrations to the contrary. Would we find any virtue in the legalization of our privately or publicly controlled universities, we may say that this guarantees a certain protection to the tools with which our faculties work and legal supervision of the custodianship of such things of value which private citizens have at times given to the university to improve the tools of the faculty.

It is well to understand of what such tools consist. They are the records of past workers and the material necessities of the present—among the first, books and such other evidences of its labors as a bygone generation may have seen fit to leave behind; among the second, our buildings and their contents from penwipers and kitchen chairs to tubes of rare gases and janitors. It is entirely in keeping with America's veneration of property rights that legal supervision of the university should be most evident in the protecting hand which it spreads over her material aspects. Some day perhaps our country will attain the standard of the middle ages and extend an equal protection to the men that constitute the university, for, after all, the carpenter's chest is not the carpenter, and while the workman may make him new implements, the rarest tools need hands and minds to guide them.

It is evident from these simple considerations that the sine qua non of a university ever has been and ever must be a group of clear thinking individuals possessed of expert knowledge gotten at first hand. The wobbly logician is useless from the start. Neither does mere possession of much or even expert knowledge make the university type. Teachers in primary grades and the high school are supposed to have as much, and certainly the teaching staff of a technical school. The university man is more than a mere animated manual of useful information in captivity. What we expect of him is not instruction in facts but instruction in methods, and how can he teach others to analyze world problems who has not learned himself?

Let it not be assumed that this obvious point of view so glibly and generally assented to in spirit is as readily adopted in the specific university problem. There is ever a deal of cry for the "practical" man in university instruction who will give our sons and daughters the immediately applicable formulæ for curing headache, shoeing horses, freezing ice cream and raising hay. I am by no means opposed to such

things, only let us not forget what their real place is, and by over-emphasizing them as ends in themselves create in our universities an atmosphere in which a thinking doctor, an engineer who knows principles, a real physiologist or a real agriculturalist can never be made. John M. Coulter has summed it up well: "We are interested in the practical application of knowledge rather than in practical work without knowledge."

It does no harm to try to visualize the university as we have defined it. Its beginnings go back to before the days when the word was born. The shepherd who first distinguished the wanderers from the fixed among the stars breathed its spirit. Socrates and Galileo were good-sized universities in themselves. The academies of the middle ages were the beginnings of the modern, more formal conception of the university. They were collections of men who thought for themselves of matters universal, and taught others how to think. There are some universities in Germany. The name is no guide to them in America. A change in name hardly makes a college, a finishing school or a state-controlled chicken ranch into a university. No doubt degrees may be acquired, and the ambition "to make friends that will be useful in after life," to dress simply and yet expensively, to gain the assurance necessary to live off father's farm, may all be satisfied in many of these places, but is this a university education? With what mixed feelings one reads the autobiography of a Darwin! After two years in Edinburgh and after three in Cambridge he writes, wasted. Only his open holidays stand out when he walked the fields with Henslow and in him found the university. And what shall we say of the institutions usurping the name which for a quarter century allowed Darwin to work at their doors, to achieve that which brought a new salvation, to attain universal recognition, before they themselves invited him in? Must every generation learn anew that a university is not a neat package of fixed ideas, but a place offering sanctuary to unshackled thinking?

A faculty does not, however, constitute the whole university in the minds of the average public. There are boards of trustees, presidents, and we might add, deans, to be considered. Few institutions in the flesh have given rise to bitterer discussion. To understand the why of this and the merits of such discussion we need but recall the history of their development and interpret their acts in the light of what constitutes the spirit of a university.

The best universities, perhaps the only universities known, and the spirit of which every country is busy copying, have no boards of trustees whatsoever, and no presidents. The faculties in them elect each year a dean, and since there is but one of him he might be called a president. But he is not chosen because of his ability to get money for a hard-up institution, to collect or dismiss a faculty, to meet the legislators in the lobby or the well-to-do in their homes, but as an acknowledgment on the part of his confrères of his contributions to the thought of his day. His influence over his faculty is the silent influence of leadership, not the noisy one of accidental power. For trustees in these universities there is no need, for auditing clerks are sufficient to visé bills, the amounts of which may not exceed appropriations originally settled upon when the professor assumed charge. A department is judged by results and not by the neatness of its correspondence files and signed bills.

There was something of this same spirit in the original American universities. There were boards of trustees, but originally

all, and even to a late date many members of such were members of the faculty. The boards had, in other words, delegated to them administrative powers and duties which they could do better than the faculty—clearly a step forward in the terms of efficiency. With time, however, faculty representation in the board became less conspicuous. Originally, the reasons for this were also not bad. A university is the embodiment of certain educational ideals, and it was, of course, to be expected that many not directly connected with a faculty, but interested in the progress of education, should seek opportunity to labor for it. And why should not such labor receive acknowledgment in a position of administrative trust on a university board?

There must have been much of mutual help in a meeting in which men of the outside world brought to cloistered students their practical suggestions, while those within aided the outsiders to catch the ideals of the universities, all presided over by a president chosen for his first-hand knowledge of educational problems. Had things remained so it would have been well for all concerned. But exactly as the past decades found more to admire in the investment banker than in the builder of the road, and more in the squirter of water than in the engineer, so the superintendents and employers of the faculty came to mean more than the output of the university itself.

Excessive attention to the machinery of the university has served to blind us to the obvious fact that it is but a tool and that what we want is more product. There is a law of diminishing returns in the administration of universities as in other forms of activity. In too many spots in our country the administrative tail has wagged and wags the dog. I know the dominant member of a university board who habitually refers to the teaching staff as the hired help. It seems no accident that the strong men of this faculty have found more congenial fields of labor elsewhere. Even national bodies dedicated to the advancement of university education get stung by the efficiency bee. A member of such once classified the engineering branches of our universities on the basis of money spent per student hour. Weaker than the report were the backs of many university attachés which bent under the weight of its fearful authority; nor did stiffness flow back into them until President Maclaurin killed the hundred-and-thirty-page Goliath with a two-page pebble in which he pointed out, what might have been recognized before, that the efficiency of a university is not to be reported on in the same way as the efficiency of "a glue factory or soap works."

It has been urged in extenuation of the gradual acquisition of all administrative powers by trustees and president that such has been made necessary by the weakness of our faculties. Relatively speaking, they have hardly been weaker than many of the superimposed administrators, but in the absolute we have not been so strong as we might. And the reasons for this too are not far to seek. Being so largely ignorant of what really constitutes the spirit of a university, it is but natural that we should have pursued and still pursue a course which keeps a chronically weak-kneed faculty in professorial chairs. In expressing to a friend one day the opinion that the Chinese would one day become a world power, he retorted that he did not think so, because for several hundred years they had not given birth to a new idea. This would, I confess, seal their fate in my eyes were it not for the fact that for these same centuries the Manchus holding sway over them have discouraged all original thinking by the chopping off of heads.

There are a lot of Manchus in our American universities. One of the worst of these is the insecurity of the teaching position held by the professor. It is a tremendous element in the development and supremacy of the German university that her professors are appointed for life and are, to all intents and purposes, not removable for anything short of murder. Big men enlist for such prizes, but not for jobs which terminate automatically every academic year or at the pleasure of a new president or new board of trustees. It will be answered to this that men inadequate for professorial positions must be gotten rid of for the benefit of the university. True, but the way out of the difficulty lies not in the dismissal of professors. The men concerned should never have been appointed to professorships, for assumption of their chairs could hardly be expected to change them much.

But as certainly as our professors should not be subject to dismissal except under the most exceptional circumstances and then only when judged by their peers, equally certainly should there be a quiet burying-ground for the walking dead. The conquest of our universe is the advance of an army, into which many have entered and all should be allowed to, but of which only the picked may live to take final command.

The recruiting of our university faculties begins to-day in the positions for graduate students, fellows and assistants. They form good starting-points and should be as numerous as possible in order to give all those who are called or think themselves called, an opportunity. Of the numerous starters, merit should in due season bring reward to the better ones, and these be made instructors, assistant professors, or, if you please, associate professors. It is in this ascent of the hill that the weak should drop out and under. If properly supervised they might be pushed out and under. It should be understood at all times that a university is not a hospital for the infirm.

Hastily viewed, our present system seems to offer just such opportunities, but in practise an almost opposite result is obtained. It can hardly be said that every one may enter the lists for a university career. On the other hand, once in, the purest bone with long life and robust health may attain a top place. Everything encourages this. If short in virility and long in servility any one may mount in the course of several years from four hundred to a thousand or fifteen hundred. Non-objection to domestic service tempts him into matrimony, and pity for the young couple encourages the raise to eighteen hundred. The third reel tells the story of the rest of this university man's life. He is acknowledged no good, he has not the desire or nerve to quit, and he is not pushed out because he is married. Our universities are full of such men. They are the food of caricaturists and satirists and yet our universities themselves make them. Nor will they become of historical interest only until we stop filling up our teaching bodies with men whose first virtue is their cheapness. The day must come when we will frankly draw a monetary dead line at the point where a man can just live alone and bid him die there unless the character of his work is such that he is accepted into the fold of university-sized men and thereby at once assured decent compensation for a family and life tenure of office. There should be no stepping-stones across this gulf. However agreeable to the chief the placid acceptance of his ideas by the subordinate, however admirable length of service, such do not make the university professor, and university rewards should not be his.

There should, however, be opportunity for the capable university man who has

still to gain the coveted upper place, to work and teach without subserviency. It is unfortunately true that, being human, even great men find virtue in the merely faithful dog, and under the prevailing system of appointment in America, where to stand in with a powerful professor or to be the graduate of the right school means more than accomplishment, such can not help but prosper. And yet it is the less agreeable young worker who thinks independently and differently that we really wish to develop. The situation brings vividly to the front the necessity of lower pitched university positions for which any man may qualify and in which he may enjoy independence and opportunity for individual thinking while receiving as compensation a fixed salary from the university administration or from the students whom he attracts. A university is not alone a collection of clear and new thinking men, but a nursery for such. As one surveys our American institutions as now constituted one wonders how, should they appear, there would fare in them a Voltaire writing "Oedipe" at twenty-two, a Michelangelo carving the young St. John at twenty, a Galileo discovering the isochronism of the pendulum at nineteen.

The American has been accused of being racially without individuality. All the men tighten or bag their clothes in the same season and all the women replace, if so able, felt with straw on Easter day. These things mean in toto a desire to stand with the majority, and it is but natural that to so stand should be considered right, for such view receives constant encouragement in a land where the voice of the many is the voice that rules. It is this view carried into our universities that has done so much to keep us well in the rear. Neglecting for the moment its mischievous consequences from the standpoint of material support and development, for it is not easy to impress the ideals of higher education on a grammar-school mind, this majority view has blinded trustees, presidents, faculty members, and the public at large to the real purposes of a university by demanding that they of it constantly exhale this. But to be of university size its men have very decidedly to voice a *minority* point of view. To believe in and teach the circulation of the blood in 1914 does not make or require a university man. The time for this passed about 1628. Nor will our universities reach a higher level before we have accustomed ourselves as a nation to expect heterodoxy in them and have learned to like it so well that we encourage it. Sovereigns, men of power and of wealth, governments even, have for centuries known this, and spread their protecting hands over the men of their universities to the point even of putting them above the law. It is the blighting influence of the majority demanding that its view be taught in all its schools which has so long made our state and municipal universities lag behind the privately endowed. Democracy owes the latter an unpayable debt in the examples they have given of how to breed and develop that minority point of view which time makes a majority one.

How to encourage this one thing for which our universities exist is well illustrated by those of Germany. Our colleagues there enjoy complete freedom of teaching. It is not expected of them that each shall teach the same thing and in exactly the same way. With us there must be so many hours of this and so many hours of that, all neatly divided according to rules and regulations laid down by the latest college conference. Why not as many hours as possible of that which the man knows best and then another man or another institution for another phase of the same or a

different subject? How can a new point of view come into being or be developed except as we let those whom we have assumed to be able to foster such alone, to spread the new belief with all the power in them? When this day comes men will again call themselves the products of men and not, as now, the products of teaching factories.

But the undertow of interference with freedom of teaching actually goes deeper than this formalism. In Germany even a docent teaches as and what he pleases, and this in spite of all our notions regarding restriction of expression of opinion under European flags. With all our extravagant claims of free press and free speech, our universities are forever debating whether this or that may be discussed in a class room and this or that speaker may use our platforms. Presentation of any living issue, especially if it involves politics, religion or the social sciences, seems tabooed from the start. And yet if subjects with a little less perspective than that given by four hundred years are not the true raw material upon which our universities are to work, what are? Must we forever in practise admit the truth of the father's view in Shaw's play who sends Fannie to Cambridge because he knows that there, if anywhere, will be found alive the atmosphere of the eighteenth century?

We can not leave to anyone's censorship the matter of who and what may or may not be heard in the forum of our universities. We have learned to honor a Luther because he preached the bars down in matters religious; a Jefferson because he preached them down in matters political; a Humboldt because he preached them down in matters educational. The university preaches the bars down for the discussion of all subjects. Those who visit her do not come to be taught a gospel but to use judgment in selecting the best from the gospels presented.

It remains to justify this special protection, this, to some, reckless use of material wealth in support of those who constitute a university. But what need we say of those who have proved themselves the greatest single force for the increase, distribution and maintenance of the one universally desired and valuable commodity—happiness? Can we express in comprehensible values the freedom given the mind by a Newton, a Herschel, a Laplace? Has the public ever paid too much for the blows to superstition of Vesalius, Servetus, Agassiz? Do we remember that for the dynamo and motor and their thousand delightful consequences England never paid Faraday more than twenty-two hundred dollars a year? Was a docent's income too high a price for the Hertzian waves and wireless? Has any one counted up the hours of pain that ether and chloroform have forever abolished? Do we walk daily through pestilence and remember to bend the knee to Pasteur? Shall we detail the millions which a Liebig has added to agriculture? Have we gained anything when the desert brings forth fruits and the swamp something besides death? Will Smith, Laveran, Ross and Reed be even thought of when the boats of a hundred nations push their way through the Panama ditch which the work of these men alone made possible?

If we would further replace intolerance by tolerance, superstition by knowledge, hunger and famine by food, sickness by health and death by life, if we would see happiness where there are tears and blood, the way is clear. A university is not a luxury for the favored of fate. From her cup drink alike and are satisfied sovereigns by the grace of God, aristocrats, bourgeois and proletariat. If gratitude is a

thing of the human heart all classes owe her allegiance. In her the rarest individualist and the broadest communist find common ground. Individuals have freed the many, which, would they remain so, must nourish the fields from which their liberty has sprung. When democracies forget, the individual may rise to do what the many should. A Vilas, a Carnegie, a Rockefeller puts governments to shame. To discover among us the pioneers of thought and to set them at the world's work is university business, and he who does this, be he philanthropist, trustee, president, or faculty member, is a university man.

However uneven the progress of the university, however in innocence or by intent those momentarily in command may chasten her spirit, the need for her will keep her alive. The ever-new problems of an ever-changing universe guarantee this. In the history of our world that religion has always been best which has been newest, because the newest takes greatest cognizance of and tries best to meet the problems of the age in which it is born. Religion invites defeat because it attempts to do more than this by prescribing for all the future which no age and no spokesman for an age can foresee. For the same reason political constitutions ultimately meet amendment or pass out entirely. Our forefathers could hardly draft laws to meet the problems of steam transportation, of telegraphic monopoly, of meat trusts and the thousand other things that our own age has discovered. Only science, which on new evidence will change all her laws over night, is as secure to-morrow as she is to-day. Her spirit is the spirit of the university to which alone the strong will and the weak must forever bow.

MARTIN H. FISCHER

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE[1]

WITH the continued enlargement and extension of the functions of the United States Department of Agriculture, the annual appropriation act providing for its support has become more and more a measure of much public interest. The latest of these acts, signed by President Wilson June 30, 1914, and carrying appropriations for the fiscal year commencing with the following day, is no exception in this respect, again establishing as it does the principle of federal aid to agriculture in the broadest use of the term, providing for the maintenance and development of its manifold activities to a larger extent than ever before, and opening the way to an increased efficiency through a reorganization of its work.

The total amount carried by the act is $19,-865,832. This is an increase of $1,878,887, or over 11 per cent. over the previous year, and of $804,500 over the estimates submitted by the department. The increased allotments are distributed throughout the entire department, and while many are designed to provide more adequately for its administrative and regulatory functions, which now absorb nearly two thirds of the total appropriations, opportunity is also afforded for the extension of most of its lines of research, and especially for the development of its various forms of demonstration work.

In its general make-up, the law conforms closely to its immediate predecessor, and in fact is somewhat more rigidly confined to the routine work of the department. There are, however, a number of items of new legislation. Thus, the Secretary of Agriculture is directed to prepare a plan for "reorganizing, redirecting and systematizing the work of the Department of Agriculture as the interests of economical and efficient administration may require." This plan is to be submitted to Congress with the estimates of expenditures for the fiscal year 1915–16, these estimates being arranged on the basis of its provisions. A special object of the proposed reorganization is the elimination of the possibility of duplication, and the securing

[1] From the *Experiment Station Record.*

of close coordination of related lines of work.

Another provision increases the maximum salary which may be paid to investigators or others engaged in scientific work from $4,000 to $4,500. Under the previous limit, a number of the more experienced investigators have been drawn away from the department.

By a clause inserted in the section dealing with the Office of Experiment Stations, funds are given the Secretary of Agriculture to carry out the provisions of the Smith-Lever Extension Act. An extension of the franking privilege is also included under which all correspondence, bulletins and reports for the furtherance of the purposes of that act may be transmitted in the mails free of postage by the college officer or other person connected with the extension department of the college designated by the Secretary of Agriculture, under regulations to be prescribed by the Postmaster General.

Great interest was again manifested in the demonstration and extension activities conducted by the department itself, and some of the largest increases carried in the act are those for their further development. The sum of $400,000 is definitely allotted to farmers' cooperative demonstration work outside the cotton belt, and $673,240 for similar demonstrations in the areas threatened by the boll weevil. In the case of the latter work, a proviso is inserted restricting the expenditures to the funds provided and such cooperative funds as may be voluntarily contributed by state, county and municipal agencies, associations of farmers and individual farmers, universities, colleges, boards of trade, chambers of commerce, other local associations of business men, business organizations, and individuals within the state. The allotment for the campaign against the cattle tick is increased from $325,000 to $400,000, of which $50,000 may be used for live stock demonstration work in areas freed of ticks. There is also an appropriation of $60,000 for experiments and demonstrations in cooperation with states or individuals in live stock production in the cane sugar and cotton districts, and one of $40,000 to aid in the agricultural development of the government reclamation projects by assisting settlers through demonstrations, advice and in other ways.

Most of the various regulatory or police functions assigned to the department receive increased support. The permanent appropriation of $3,000,000 for meat inspection is supplemented by a grant of $375,000, an increase of $175,000 over the previous year. This increase is mainly because of additional work through the inspection of imported meats, in accordance with the Tariff Act of 1913. The meat inspection is also extended to reindeer. The allotment for the enforcement of the Food and Drugs Act is increased by $25,641, largely to meet the additional duties imposed by the recent extension of the act to include meat and meat food products and the amendment requiring the declaration of the net weight in package and similar goods. An increase from $10,000 to $50,000 is provided for the protection of migratory game and insectivorous birds, and one from $75,000 to $100,000 for the cooperative fire protection of the forested watersheds of navigable streams. The appropriation for the enforcement of the plant quarantine act is increased from $40,000 to $50,000, with $50,000 additional to enable cooperation with states quarantined against the interstate movement of Irish potatoes.

As usual there is considerable new legislation relating to forestry matters. The Appalachian Forest Reserve Act of 1911 is amended by increasing the proportion of the gross receipts from the National Forests acquired under its provisions which is returned to the respective states and counties, for the benefit of their public schools and roads, from five to twenty-five per cent. Provision is also made for the handling through the Treasury Department of funds contributed for cooperative work in the protection and improvement of the national forests, as well as for forest investigations, and a requirement is inserted whereby all such contributions must annually be reported to Congress.

The appropriation for studies of the marketing and distribution of farm products is increased from $50,000 to $200,000. Authority

is also given the department for studies of cooperation among farmers in the United States in rural credits and other lines and to disseminate information on the subject, with an appropriation of $40,000 for the purpose.

Other new projects for which definite appropriations are made include $10,000 for the importation of Corriedale and other sheep for breeding purposes; $5,000 for studying the grading, weighing, and handling of naval stores; $7,000 for the publication of reports and maps dealing with the location, extent, etc., of the kelp beds on the Pacific Coast; $10,000 for furnishing official cotton grades and samples to certain associations; $5,000 for the improvement of an additional game preserve; and $5,000 for agricultural extension work in Hawaii. Authority is also given for studies of seismology, a number of new insects and plant diseases, the handling of fish, oysters, and other foods and food products, and the utilization of agricultural products for clothing and other uses in the home. An exhibit by the department, illustrative of farming in the subhumid regions, is provided for the International Dry Farming Congress to be held at Wichita, Kansas, October 7 to 17, 1914, with an appropriation of $20,000 for the purpose.

Considering the appropriations definitely allotted to the several bureaus, that of the Weather Bureau aggregates $1,667,270. This is an apparent decrease of $40,340, but this is mainly because no new observatories are provided except a building at Neah Bay, Washington, to cost $3,000. The allotments of the bureau have been classified on a new basis, $327,270 being available for statutory salaries; $122,000 for carrying on investigations in meteorology, climatology, seismology, evaporation and aerology, and the dissemination of meteorological, climatological and marine information in the city of Washington; $1,189,000 for similar expenses outside of Washington, and $26,000 for the maintenance of a bureau printing office in Washington. The Secretary is also directed to report to Congress relative to the future disposition of the plant at Mount Weather, Virginia, from which the extensive research work formerly carried on is being largely withdrawn.

An increase of $288,830 is accorded the Bureau of Animal Industry, making its total $2,320,026. This is in addition to the permanent annual appropriation of $3,000,000 for meat inspection previously referred to and also to a special appropriation of $600,000, approved February 23, 1914, of which $50,000 was allotted to the inspection of virus, serums, etc., used in the treatment of animal diseases, $100,000 for the investigation, treatment and eradication of dourine, and the remainder for similar work with hog cholera. Among the largest items of increase in the bureau's appropriation are those supplementing the meat inspection funds and for the tick eradication campaign already mentioned, and for work in dairying which receives $256,490, an increase of $78,590. The various items pertaining to animal husbandry are combined into a single group aggregating $182,840, of which $30,000 may be used for the horse breeding project, $24,500 for the poultry studies, including the ostrich industry, and $10,000 for sheep importation. The appropriation for inspection and quarantine work is $625,520, and that for pathological investigations of animal diseases $77,360.

The Bureau of Plant Industry receives $3,616,045. This is an increase of $948,050, about two thirds of which is accounted for by the large additions to the funds for demonstration purposes previously mentioned, and the remainder chiefly by smaller increases apportioned among a large number of projects. The congressional seed distribution is continued on the usual basis and with an appropriation of $257,000, as for the previous year. The bureau also receives $166,500 for the testing and distribution in quantities sufficient for practical field tests of new and rare seeds which from previous trials seem especially promising, and for the improvement of alfalfa, clover and other forage crops, $100,000 of this amount being available for the purchase and distribution of these new and rare seeds. The amount of $74,600 is appropriated for the foreign seed and plant introduction.

Large appropriations are again made for the

prosecution of studies with specific crops. Thus, for cotton $91,000 is provided for an inquiry into ginning, grading, baling, and wrapping practises. This work is extended to include gin compressing and the distribution of the official grades of cotton samples, and the appropriation for testing the waste, tensile strength, and bleaching qualities of the various standard grades of cotton is increased from $10,000 to $60,000. For other fiber plant studies, especially with flax, $20,850 is again allotted, as well as $38,000 for acclimatization and adaptation work with cotton, corn and other crops introduced from tropical regions. The tobacco studies receive $25,000; the cereal investigations $135,405, of which $40,000 is for corn; the studies of grain handling and grading $76,320; those of drug plants $55,380; and those of sugar beets and the production of table sirup and the means of utilizing cane by-products $41,495. For studies in fruit growing, handling and marketing $107,500 is available, together with $56,320 for other horticultural work, and $26,690 for the maintenance of the various departmental greenhouses and the Arlington Experimental Farm.

Another large division of the work has to do with plant diseases, $37,000 being available for the maintenance of the general pathological laboratory and the herbarium of plant diseases, $52,675 for fruit diseases, $69,510 for those of forest trees and ornamentals, and $46,000 for cotton and truck crops. For plant physiology and plant breeding there is allotted $44,540, together with $22,280 for the breeding and physiological study of alkali and drought resistant crops. There is also $35,000 for soil bacteriology and plant nutrition studies, $25,000 for biophysics, $24,000 for economic and systematic botany, $28,700 for studying and testing commercial seed, $5,000 for studies of methods of utilizing logged-off lands, and $230,380 for studies of crop production and land utilization under arid and semi-arid conditions.

The Forest Service receives as usual the largest allotment of any bureau, its aggregate being $5,548,256 as compared with $5,399,679 for the previous year. There are also available the various appropriations under the *Appalachian Forest Reserve Act* already referred to, certain unexpended balances from the previous year, and an appropriation of $100,000 for fighting and preventing forest fires in cases of extraordinary emergency, this being a reduction from $200,000. The bulk of the appropriation is, of course, to be devoted to the protection and maintenance of the individual national forests, with $400,000 for the construction and maintenance of improvements, $165,640 for reforestation, $140,000 for studies of wood utilization and preservation, $150,000 for forest fire protection, $25,000 for range studies, $83,728 for silvicultural and dendrological experiments, and $40,160 for miscellaneous forest studies and the dissemination of results. The selection and segregation of lands within national forests that may be opened to entry under the homestead laws is to be continued under an appropriation of $100,000, with an additional allotment of $85,000 for the survey and listing of those lands chiefly valuable for agriculture.

The appropriations of the Bureau of Chemistry are increased from $1,058,140 to $1,077,581. The allotment for the enforcement of the Food and Drugs Act is $634,301, with $4,280 additional for the study and inspection of American food exports, $50,000 for studies of the handling and marketing of poultry and eggs, $20,000 for similar work with fish, oysters, etc., $10,000 for biological investigations of food and drug products and their constituents, and $52,400 for general investigations. Because of a transfer to the Bureau of Standards of the work of testing miscellaneous supplies purchased on contract for the various departments of the government, the appropriation for this purpose is reduced from $40,000 to $14,000.

The various lines of work of the Bureau of Soils, and the Bureau of Entomology are continued much as at present, with small increases in a number of items. The Bureau of Soils receives $360,635, an increase of $26,615, of which $11,500 is to extend the inquiry as to possible sources of natural fertilizers, particularly nitrogenous materials. The soil

survey work of the bureau is granted $169,800, with $20,000 additional for the examination and classification of agricultural lands in forest reserves in cooperation with the Forest Service, 15,265 for studies in soil physics, $22,350 for chemical investigations, and $32,700 for soil fertility work. The increase of $87,210 accorded the Bureau of Entomology is divided among its studies of several groups of insects, the largest single item of expenditure being as usual that for the gipsy and brown-tail moth campaign, for which $310,000 is available. The total appropriation of the bureau is $829,420.

The Bureau of Biological Survey is granted $281,290, an increase of $110,300. This appropriation is to be used principally for administrative and police purposes, $66,000 being allotted for the enforcement of the Lacey and McLean laws for the regulation of imports and interstate movement of game, birds, etc., $21,000 for the maintenance of the various game preserves and transfer of game, and $5,000 for the improvement of an additional preserve in Sullys Hill Park, North Dakota. The appropriations for studies of the food habits of birds and mammals and for other biological investigations, however, are nearly doubled, $15,000 being granted for the destruction of ground squirrels on national forests, $5,000 for the study of a serious disease of wild ducks in Utah, $95,000 for the destruction of wolves, prairie dogs and other injurious animals, the rearing of fur-bearing animals, and similar work, and $26,500 for field studies of the distribution and migrations of water fowl and other birds and of the bird and mammal life of the public domain.

The Bureau of Statistics is rechristened the Bureau of Crop Estimates, the new designation representing more accurately, it is believed, the nature of its work and obviating confusion with results based on actual enumerations such as are made by the Bureau of the Census. Several changes are also made in the language prescribing the work of the bureau, and the appropriation at its disposal is increased from $243,680 to $275,580. It is expected that these changes will permit of enlarging the scope and completeness of the data collected, notably as regards special crops and industries.

The various activities of the Office of Experiment Stations are continued and several of its functions are considerably extended. The total appropriation is $1,930,780, of which $1,440,000 is paid to the state experiment stations under the Hatch and Adams acts, and $50,500 (a net increase of $10,720) is for general expenses in connection with the enforcement of these acts and the Smith-Lever Act. The work of the Agricultural Education Service and of the Irrigation and Drainage Investigations is continued on the present basis with allotments of $23,000, $106,400, and $96,280, respectively, and $68,840 is granted for statutory salaries.

The total allotment for the insular experiment stations is $120,000, of which the Alaska stations receive $40,000 and those in Hawaii, Porto Rico and Guam, $35,000, $30,000 and $15,000, respectively. The act provides that of the allotment for the Hawaii Station $5,000 may be used in agricultural extension work, the territory receiving no funds under the Smith-Lever Act. The annual leave privileges of employees of the department permanently assigned to Alaska, Hawaii, Porto Rico and Guam are extended to correspond to those now applying to employees in Washington.

The appropriation for the nutrition investigations of the office is increased from $16,000 to $25,760 and the authority hitherto granted to study means of utilizing agricultural products for food is broadened to include clothing and household equipment. With the enlarged appropriation it is proposed to continue and extend the studies of food with reference to nutritive value and economical use in the home, studying both popular and technical problems, the latter including, among other things, the calorimetric study of changes which take place in fruits and vegetables during ripening and storage. In the case of clothing and household equipment, such questions, considered from the standpoint of the expenditure of human energy, will be studied as the relative durability, economy, and effi-

ciency of comparable materials and articles for specific purposes, the protective power of clothing of different kinds, the relative value and efficiency of different materials and methods with reference to household labor, the relation of the diet to body efficiency, and similar questions. It is believed that the results of such investigations will be of much interest not only to the housekeeper but also to the general public since they will furnish definite information along lines hitherto very inadequately studied but of great importance in the consideration of questions of rational and economical living. They should also be of direct benefit to the farmer since agricultural production is influenced to a very great extent by the demands of the home.

The salary of the director of the Office of Public Roads is increased from $4,000 to $4,500, and the appropriations as a whole from $279,400 to $352,560. The principal increase is one of $40,000 for studies of road building and maintenance, making $145,000 available for the purpose, special emphasis to be directed to the ordinary sand-clay and dirt roads. Increases of $4,800 are also granted for road management studies, $6,260 for tests of road materials, and $15,000 for field trials of various materials, types of construction, and road equipment.

The work of the remaining branches of the department is continued substantially as at present. The increasing administrative work is evidenced in the enlarged allotments for the office of the secretary, rent, and miscellaneous expenses for which $339,880, $108,329, and $110,000, respectively, are available. As a result of recent legislation whereby the administrative auditing of accounts is now carried on in the several bureaus, the appropriation for the Division of Accounts and Disbursements is reduced from $104,370 to $46,320. The Division of Publications receives $189,500 and the Library $45,360.

In connection with the appropriations included in the act itself, reference should also be made to the funds derived in other ways. For the fiscal year under discussion, permanent appropriations under the department aggregate, exclusive of those recently provided by the Smith-Lever Act, $5,999,200, the largest items being those of $3,000,000 for meat inspection and $2,000,000 for the acquisition of lands for the protection of watersheds of navigable streams, and the remainder being almost wholly for forestry purposes. The appropriation act for sundry civil expenses carries an appropriation for the department printing and binding of $500,000, an increase of $10,000, of which $137,500 is for farmers' bulletins and $47,000 for the Weather Bureau.

When it is recalled that large appropriations will also be available for agricultural education in the land-grant colleges under the Morrill and Nelson acts, for the rural education work of the Bureau of Education, demonstration work in agriculture among the Indians, and the payment of the country's quota toward the support of the International Institute of Agriculture, the wide extent to which the principle of federal assistance to agriculture is being carried into practise becomes apparent, and the aggregate expenditure from the federal funds appears increasingly impressive. As was pointed out by Chairman Lever of the House Committee on Agriculture, however, the entire agricultural appropriation is still inconsequential as compared with the total federal appropriations, the magnitude of the agricultural interests of the country, or even of the annual losses to farm products sustained through insect pests and plant diseases.

Moreover, the conviction is deepening that these appropriations are largely in the nature of a permanent investment for the benefit of the nation as a whole. In the words of Hon. C. G. Edwards of Georgia,

In extending these various benefits and advantages to the farmers we are but doing a simple justice to the sinew and backbone of our great citizenship. In helping the farmers we are helping the whole country, for every class is dependent upon the farmer. . . . We can do nothing that will make for the future welfare of our country more than to aid in this work, which means the establishing of farms and homes. . . . In making appropriations to improve agricultural conditions we are "casting bread upon the waters," that will return not only to feed

the people of this country, but will mean a tremendous increase in our annual farm productions, and will add to the country's wealth, prosperity, happiness and greatness.

THE PANAMA EXPOSITION

PRESIDENT CHARLES C. MOORE, of the Panama-Pacific International Exposition, to open in San Francisco on February 20, 1915, has issued the following statement:

One month ago the decision of the Panama-Pacific International Exposition management not to postpone was first published. The development of events since then, in their relation to the exposition, all tend to confirm the wisdom of that original decision.

At the time the decision was made no word had been received from any foreign nation as to the effect on its plans caused by the European war, but it was hoped that at least those nations not fighting would go on with their plans. Later developments have proven that hope well founded; in addition, we have definite assurances from France, from Italy, from Turkey and from Japan that their intentions are unchanged. Holland has added $300,000 to her original appropriation. Italy has ordered work on her building and exhibits rushed. Japan has asked for and received an increase of space. The Argentine Republic has increased its appropriation from $1,250,000 to $1,750,000.

We shall undoubtedly lose some of the promised exhibits from Europe, but not by any means all of them and not by any means the most important of them. Both Germany and Great Britain will be represented by individual exhibitors or by associations thereof. We shall undoubtedly lose some of the promised entries by European champions in the athletic events, but the international character of those events will not be lost. We may lose some of the art treasures promised us for the Fine Arts Building, but we shall gain others because of the war.

Of compensating gains we have many. There is a very sharp demand for space from the manufactures of this country, of South America and of the European nations not at war. The Exposition suddenly becomes an important factor in an extraordinary economic situation. It is seen to be the one, great, easy, efficient way by which American-made goods can be brought to the direct attention of the distributors and consumers of South America and the Orient. The latter are coming here in force in 1915 to make new individual and commercial connections forced by the war.

As regards attendance, every transportation expert confirms the opinion that a continued European war is likely rather to increase travel to California in 1915 than to reduce it.

The Exposition is 92 per cent. ready to-day. It will open February 20, as planned—and it will be, as planned, the most beautiful and most interesting exposition ever seen. There is no reason to believe that the success of the exposition, in any phase, will be any less than that which was so certain before the European war broke out and it is certain to be even more important commercially than was ever dreamed.

THE FRANKLIN MEDAL

SAMUEL INSULL, ESQ., of Chicago, Illinois, writing under date of December 23, 1913, to the board of managers of the Franklin Institute, Philadelphia, stated that he had been informed it would be a source of gratification to them if the institute had available, in addition to such medals already in its gift, a medal to be known as the Franklin Medal, and to be awarded from time to time in recognition of the total contributions of individuals to science or to the applications of physical science to industry, rather than in recognition of any single invention or discovery, however important. He agreed to provide for the founding of this medal under the following general conditions:

1. That an amount not exceeding one thousand dollars should be furnished by him for procuring appropriate designs and dies for the medal and diploma.

2. That the medal should possess distinct artistic merit, and have on one side a medallion of Benjamin Franklin done from the Thomas Sully portrait in the possession of the institute.

3. That the medal should be of gold and have an intrinsic value of about seventy-five dollars.

4. That the sum of five thousand dollars should be provided by him to be held in trust in perpetuity to be a foundation for this medal, and to be known as the Franklin Medal Fund (founded January 1, 1914, by Samuel Insull, Esq.).

5. That the interest of this fund should be used from time to time in awarding the Franklin medal to those workers in physical science or technology, without regard to country, whose efforts have, in the judgment of the institute, done most to advance a knowledge of physical science or its applications.

6. That any excess of income from this fund, beyond such average annual sum as might be deemed necessary by the institute for the number of medals it is considered best to award, might be used for premiums to accompany the medals.

Mr. Insull said he understood that the institute would be glad to award, on the average, two Franklin medals a year. Though this would leave little surplus, he inserted the sixth condition to prevent an undesirable accumulation of the fund.

At the stated meeting of the board of managers, February 11, 1914, the above offer was accepted, and the medal has been designed by Dr. R. Tait McKenzie, of the University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS

Among the German scientific men who have affixed their names to a manifesto renouncing the honors conferred upon them by English universities and other learned institutions are Professors Paul Ehrlich, Emil von Behring, Ernst Haeckel, August Weismann and Wilhelm Wundt.

Dr. F. M. Urban, professor of psychology in the University of Pennsylvania, is in Austria, and is said to be with the Austrian army.

Dr. David Todd, professor of astronomy at Amherst College and Mrs. Todd, about whom there has been some anxiety, have been reported to be in Petrograd.

Mr. Wenceslas Kotehekow, assistant Russian agricultural commissioner, and Mr. Wladimir Generasoff, secretary of the Russian agricultural agency, have been in this country to study agricultural conditions.

Dr. Benjamin Meade Bolton, of the Bureau of Animal Industry, U. S. Department of Agriculture, sailed from New York for Cuba on August 29, to conduct a campaign for the Department of Agriculture of Cuba against hog cholera.

Drs. Warren A. Dennis, St. Paul; William J. Mayo, Rochester, and James E. Moore, Minneapolis, the committee on cancer of the Minnesota Public Health Association, have been invited to act as the Minnesota state committee on cancer for the American Society for the Prevention and Control of Cancer.

Sir Ernest Shackleton has appointed Mr. Alexander Stevens, assistant in geography at Glasgow University, to be geologist and geographer to the Weddell Sea party of his expedition.

James C. Todd, professor of pathology at the University of Colorado, has been granted leave of absence for the academic year.

The Philosophical Union of the University of California celebrated its twenty-fifth anniversary on August 26, when Professor Josiah Royce gave an address on "The Spirit of the Community."

Professor Frederic S. Lee gave the address at the opening of the present session of the College of Physicians and Surgeons of Columbia University on September 23, 1914, taking as his subject the relation of the medical sciences to clinical medicine.

The Huxley Memorial Lecture at Charing Cross Hospital on recent advances in science and their bearing on medicine and surgery will be given by Sir Ronald Ross, on November 2.

Dr. Morris Longstreth died on September 19 at Barcelona, Spain. On August 29 his wife died also at Barcelona. Dr. Longstreth was born in Philadelphia, in 1846. He was professor of pathological anatomy at Jefferson Medical College, a fellow in the American Association for the Advancement of Science, a member of the American Philosophical Society and one of the founders of the Association of American Physicians.

PROFESSOR CHARLES LADAN ADAMS, professor of drawing and descriptive geometry in the Massachusetts Institute of Technology, died at Antwerp, on September 16, following an operation for appendicitis.

DR. W. H. GASKELL, F.R.S., university lecturer in physiology at Cambridge University, has died at the age of sixty-six years.

Nature records the death of Mr. H. M. Freear, chemical assistant at the Woburn Experimental Farm and pot-culture station of the Royal Agricultural Society, and a leading authority upon the relation of pot-culture experiments to practical agriculture and horticulture.

PROFESSOR B. ALFRED BERTHEIM, member of the Georg Speyer Haus in Frankfort a M., being drawn to join his regiment, lost his life on August 17 at Berlin, in consequence of an accident, at the age of 35 years. The *Chemische Zeitschrift* relates that besides work in alkyl combinations of thallium (with Professor R. J. Meyer) and hydrates of molybdic acid (with Professor Rosenhinn) he has published numerous articles, partly with Professor Ehrlich and Dr. Benda, on nitro- and aminophenyl arsenic acid and their derivatives, on p-aminophenolarsenic oxide, diamino arsenobenzyoles and their derivatives. Professor Ehrlich writes in the *Frankfurter Zeitung*, that to Bertheim belongs the distinction of having accomplished the synthesis of salvarsan. Lately there has appeared from his pen an exhaustive "Manual of Organic Arsenic-combinations."

THE London *Times* reports the death at Sedbergh, of Mr. William Erasmus Darwin, aged seventy-four. He was the oldest son of Charles Darwin, and to his birth may be attributed the origin of a notable department of his father's researches. In his autobiography Charles Darwin says: "My first child was born on December 27, 1839, and I at once commenced to make notes on the first dawn of the various expressions which he exhibited, for I felt convinced, even at this early period, that the most complex and fine shades of expression must all have had a gradual and natural origin." These notes were intended to furnish a chapter of "The Descent of Man," but the importance of the subject ultimately demanded a separate volume—"Expressions of the Emotions in Man and Animals," published in 1872. Four sons of Charles Darwin have attained scientific distinction.

A GIFT of £20,000 has been promised to London Hospital by Mrs. E. S. Paterson for cardiac research work.

BUSINESS and finance in South America are so much affected by the war in Europe that the Chilean minister at Washington has been officially notified that the Pan-American Congress of University Students will not be held at Santiago. It is said that several delegates from the United States are on their way to Chili.

INSTEAD of inaugurating a department of health for Canada, it has been decided that the Canadian Conservation Commission shall look after all health matters in the Dominion. In August the first number of a bulletin was issued to doctors, teachers and others interested in public health work, and will, thereafter, continue to be issued each month.

THE Comité des Forges de France has been obliged to cancel arrangements for an autumn meeting of the British Iron and Steel Institute in France this year. In the circumstances, the council of the institute has decided that it would be advisable to postpone for the present any alternative arrangements for an autumn meeting for the reading and discussion of papers.

THE meeting of the Fourth International Congress on Home Education and the eighth meeting of the American School Hygiene Association scheduled for Philadelphia during the last week in September were postponed. It was considered unwise to hold an international congress at this time. This fact became evident at such a late date as to make it impossible for the American School Hygiene Association to plan an effective independent meeting in place of the joint meeting. The next meeting of the American School Hygiene Association will occur some time early in 1915.

THE British Board of Trade has made rules under which a German or Austrian patent may be entirely suspended.

ENCKE'S comet was rediscovered on September 17 on photographs by Professor E. E. Barnard of the Yerkes Observatory. The comet's position was right ascension 3h 43m 40s, declination north 37 degrees, 46 minutes.

THE Royal Academy of Medicine of Turin offers its Niberi prize of $4,000 for scientific research in medicine. The conditions may be obtained from the secretary, 18 Vie Po, Turin.

THE Chadwick trustees announce their intention to award at the close of this year the Chadwick gold medal and £50 each to the naval and military medical officer, respectively, in the British service who shall have distinguished himself most in promoting the health of the men in the navy and the army.

THE commission of the Society of Russian Medical Men, founded in memory of N. L. Pirogov, for the study of malaria in Russia is completing the index of the Russian literature of malaria up to the end of 1913. In future the indexes will be issued yearly, together with short abstracts of the articles, including, if possible, all the literature of malaria for the preceding year. The commission will shortly edit works on leishmaniasis and other diseases due to protozoa and would therefore be grateful to authors of articles relating to this branch of medicine as well as veterinary medicine and phytopathology, if they would send printed copies of their works to the commission. Authors who send two copies of their works will receive the bibliographic index edited by the commission. All communications should be addressed to Dr. E. I. Marzinovsky, Hôpital de l'Empereur Paul I, Moscow, Russia.

THE *Journal* of the American Medical Association says the campaign against hookworm in Jones County, Miss., was brought to a very successful conclusion toward the end of August, over 2,500 cases having been treated. Hookworm was found in over 60 per cent. of all cases examined, the largest percentage being found in children. The people showed much interest and cooperated in the work. Many schools were found in which all the teachers and pupils were infected. Much infection in country schools is attributed to the ingestion of the eggs of the parasites in drinking-water obtained from springs near the schools.

MR. BENJAMIN F. GROAT, hydraulic engineer of Pittsburgh, has secured an unusually high degree of accuracy in discharge measurements on the tests of the large hydro-electric units at Massena, New York, by the use of chemicals introduced into the feed water. The use of chemicals was suggested by Schloesing in France (1863) and has since been employed in England by Stromeyer and in Europe by others in measuring small quantities of water. But by the chemical procedure devised and inaugurated by Groat, very large quantities of water may be measured with a margin of error well within one tenth per cent. Three hundred and sixty tons of common salt and one pound of silver nitrate were employed as reagents during the course of nearly one hundred tests.

ACCORDING to the *Electrical World*, an electrical device which will indicate the approach of a thunderstorm several hours before any clouds appear is being used successfully by an electric-service company in New York City to give ample time to provide for increased illumination when the thunder clouds darken the sky. The storm-detector apparatus, which resembles wireless receiving equipment, is operated by faint impulses from electrical disturbances in the vicinity. Receiving antennas intercept the impulses, which cause a relay to close an alarm-bell circuit. At first the signals are far apart, but as the electrical disturbance approaches the bell rings more frequently. From an hour to half an hour before the storm breaks, depending on the intensity thereof, the bell will ring continuously. In the meantime steam may be raised to operate generators which are placed in readiness to supply additional energy when the demand increases.

WITH the cutting off of importations of many mineral products the United States Geological Survey's list of mineral producers becomes an important source of public infor-

mation. In response to specific inquiries addressed to the director of the survey at Washington, concerning the location of mines of any kind tributary to any particular market, extracts can be furnished from this list. The list is not a published one, as it includes about 90,000 names and addresses of producers and is constantly being revised, the changes each year amounting to 25 per cent. of the list. It can be largely utilized, however, in reply to inquiries from consumers of mineral products.

We learn from the report in *Nature* that the Museums Association celebrated the completion of a quarter of a century's existence at its recent meeting in Swansea. The attendance was large, and the papers dealt in a practical way with the preservation and restoration of works of art—a subject which has never previously received so much attention at an annual conference. Representatives were sent by forty provincial museums and art galleries, five national museums (the British Museum, the British Museum of Natural History, the Victoria and Albert Museum, the National Museum of Wales, and the Museum of the Royal Botanic Gardens at Kew), and the London County Council. The presidential chair was occupied by Mr. Charles Madeley, director of the Warrington Municipal Museum, who in his address invited the conference to consider "What is the true theory of a municipal museum?"

We learn from the New York *Medical Journal* that the U. S. Senate has passed the amended Harrison bill, under which every person who produces, imports, manufactures, combines, deals in, disposes of, sells, or gives away opium or coca leaves or any combination thereof, or salt or derivative thereof, is required to register annually with the collector of internal revenue, paying a fee of one dollar for registration. This is the measure which had already been passed by the House of Representatives. It is believed that the House will agree to the amendments introduced by the Senate and in that case the measure will no doubt be promptly passed and soon become a law. This bill is a modification of the measure originally drawn up by Dr. Hamilton Wright, commissioner of the United States to the International Opium Congress. The underlying principle is that through the registration of all who are legally entitled to handle these drugs, it will be possible to prevent illegal interstate traffic. This law will supplement the various local laws and through its operation the authorities of the several states expect to be able materially to curtail, if they can not wholly do away with illegal traffic. The measure has been objected to on the ground that it requires the registration of physicians with the internal revenue department. A clause in the law unfortunately permits the sale without registration of domestic and proprietary remedies, containing so-called small quantities of opium and its derivatives.

UNIVERSITY AND EDUCATIONAL NEWS

The twenty-fifth anniversary of the opening of the Johns Hopkins Hospital, the twenty-first anniversary of the opening of the medical school, the second reunion of the alumni of the medical school and the first general reunion of the alumni of the training school for nurses, will be made the occasion of an elaborate celebration at the hospital, which will open October 5 and continue throughout the week. In connection with the celebration the annual Herter lectures will be given by Dr. Thomas Lewis of University College, London.

The following gifts to Oberlin College are announced: $50,000 from Dr. D. P. Allen and J. L. Severance, of Cleveland, for completing the new art building; $50,000 from Charles M. Hall, of Niagara Falls, for the improvement of the campus; an anonymous gift of $7,500 for furnishing the new administration building, erected at a cost of $69,500; $25,000 for a new organ in Finney Memorial Chapel, the joint gift of Frederick N. Finney, of South Pasadena, California, and G. M. Hall, of Niagara Falls. The trustees have approved the budget appropriation for 1914–15, amounting to $356,900. Of this sum $194,125 will be received from the term bills of students, $99,300 from endowments, and the balance from sundry sources.

Mr. Robert Brodie Forman, of Liverpool, has bequeathed £10,000 to the University of Liverpool.

Professor R. du Bois-Raymond, writing in the *Berliner Tageblatt*, as quoted in the N. Y. *Evening Post*, says that from Berlin University 236 lecturers, nearly half the total number, are serving their country, either voluntarily or in obedience to the law. The medical faculty furnishes 133 men, presumably for the medical service of the army.

Oxford and Cambridge Universities are opening as usual, but at Cambridge a hospital for the care of wounded in war has been organized on a large scale; Downing College is garrisoned by a hundred nurses, the Medical Schools are housing a contingent, and a wing of the Leys School, the Cloister Court of Trinity and Pembroke College are prepared for the reception of military patients. At Oxford 600 beds have been placed in the Examination Schools.

A committee connected with Oxford University has been formed, with the approval of the Belgian Minister, for the purpose of offering hospitality to professors of Louvain and their families. This committee is composed of the vice-chancellor, the principal of Brasenose College, Sir William Osler, Mrs. W. Max Muller and Miss Price.

Dr. William H. Seemann has been elected dean of the faculty of Tulane University School of Hygiene and Tropical Medicine, and the following appointments to the faculty have been made: Dr. Abraham L. Metz, professor of chemistry; Dr. Andrew G. Friedrichs, professor of oral hygiene; Dr. Isadore Dyer, professor of skin diseases; Dr. Edouard M. Dupaquier, professor of tropical medicine and acute infectious diseases; Dr. Charles C. Bass, professor of experimental medicine and director of the laboratories of clinical medicine, and Dr. Joseph D. Weis, professor of tropical medicine.

Professor Bristol, of the department of bacteriology in the College of Medicine of Syracuse University, has resigned and gone to North Dakota. In his place is Dr. Oliver Wendell Holmes Mitchell from the department of medicine of the University of Missouri, and as his assistant Mr. Ralph R. Simmons, A.M., also from the University of Missouri. Dr. F. M. Meader, associate professor of preventive medicine, has accepted the position as director of the division of communicable diseases in the New York State Department of Public Health. He has, however, retained his position as head of this department and there has been secured as his assistant Dr. Edward D. Clark, for the last three years connected with the health department of Buffalo. Dr. Howard L. Van Winkle, assistant in the Municipal Department of Public Health, has been made instructor in this department and will conduct the work in laboratory diagnosis in the municipal laboratories.

Edwin Burket Twitmyer, Ph.D., has been promoted from assistant professor to be professor of psychology at the University of Pennsylvania. Professor Twitmyer is also assistant director of the laboratory of psychology. Other promotions in the same department are: Francis N. Maxfield, Ph.D., from instructor to assistant professor of psychology; Dr. David Mitchell and Mr. Frank H. Reiter, to be instructors in psychology. Assistant Professor Maxfield will continue, as last year, to be assistant director of the psychological clinic.

Elijah Swift, A.B. (Harvard), Ph.D. (Göttingen), of Princeton University, has been appointed Williams professor of mathematics at the University of Vermont.

Halsey J. Bagg, B.S. (Columbia, '14), has been appointed instructor in zoology in New York University.

DISCUSSION AND CORRESPONDENCE

THE CARNEGIE FOUNDATION FOR TEACHERS—A SUGGESTION

Considerable criticism has been raised in this journal in regard to the method of administration of the pension system for teachers, established by Mr. Carnegie. The purpose

seems to be that teaching only of the higher grade should be rewarded by the foundation. In judging the grade of teaching, however, the character of the institution where the teacher happens to be located, and not the work of the individual teacher himself, is used as the basis of selection. The present note is to suggest for discussion the desirability of changing the viewpoint, and using the work of the teacher, rather than the institution, as the unit of selection.

Success of service in the teaching profession is properly recognized for two main reasons: First, as a reward for past service and, second, as a stimulus for attracting and developing higher grade men in the profession. The reward would be more just if apportioned according to the individual service rendered, and the stimulus would be greater upon such a basis. The indifferent men in accepted institutions may be less worthy of reward and more in need of stimulus than many in unselected institutions.

Undoubtedly one of the chief reasons for making the institution the unit of selection is the apparent relative ease of classifying institutions and administrating the system upon this basis. The difficulties of classifying and administrating upon the individual basis, however, are not insurmountable. The best judge of the success of service in teaching is the opinion of teachers themselves. In "American Men of Science," 1,000 men from the entire body of scientists are listed as of preeminent rank, the number apportioned to each department being in proportion to the total number of scientists that it contains. The essential value of this starred list is the method of its selection. Those starred are thus ranked by the combined vote of the leading scientists in the particular department which they represent. Such a method of selecting individuals could be extended to include all the departments of teaching. The number that the foundation is able to directly benefit can be determined and the list of beneficiaries can then be prepared accordingly, but be selected by the teachers themselves.

Under the present system the value of the pension may seldom if ever be directly discounted from a teacher's salary, but, to the writer's knowledge, the fact of an institution being accepted by the foundation has been offered either as an excuse for a low scale of reward or as an inducement to change institutions without rise in salary. Giving the pension through preferred institutions has little or no influence as encouragement to do better work for those already in these select institutions and, for individuals outside the fold, is of influence only as it causes them to attempt to get upon the preferred institutions even at a sacrifice.

Objection may be raised to the selection of individuals that such a method gives undue prominence to research and publications. In the grade of institutions for which the Carnegie Foundation is intended, research and publication is considered as one of the necessary activities of a good teacher. Publication broadens the class room and increases the number of scholars, making the influence of the teacher international and not merely local. The good teacher further is known by his scholars and by his colleagues. It would be impossible, therefore, for the worthy teacher to escape recognition by a jury of his peers.

It is not desirable to discuss here further the possibilities of the scheme suggested nor to point out the possible influence that a recognized list of teachers might exert upon a more direct adjustment of positions to merit than is at present in vogue in many American colleges and universities. What has been written is sufficient as a suggestion.

A. F. Blakeslee

Conn. Agricultural College,
Storrs, Conn.

JONES'S "A NEW ERA IN CHEMISTRY"

To the Editor of Science: The reference to my review of Professor Harry C. Jones's "A New Era in Chemistry," which Professor Franklin makes in his own criticism of the book in Science of July 31, may serve me as an excuse for a few words regarding this criticism.

Of the exceptions taken by Professor Frank-

lin, the validity of some may be questioned, others are obvious errors which escaped the proofreader and will doubtless be corrected in the future editions the book is sure to demand, while the remainder depend upon the standpoint of the reviewer. It is the latter point to which I wish especially to refer.

If "A New Era in Chemistry" was written as a scientific text-book or as a contribution to scientific knowledge, then any departure from the utmost scientific accuracy of statement would be justly open to criticism, but such is evidently not the purpose of the book. It is rather a singularly successful attempt to give in sparingly technical language a résumé of the salient chemical developments of the last quarter of a century. As such it is of great value, not only to workers in other branches of science, but also to some of us whose work is in other departments of chemistry.

Of course it is desirable that every statement in such a book should be scientifically accurate, and this is a result somewhat difficult of accomplishment, unless the writer takes all the "juice" out of his style by confining himself to a strictly scientific terminology. To take an example: Dr. Franklin is inclined to cavil at the following language: "Radium is naturally radio-active as it is called;" "A radio-active substance is one that gives off radiations" (and then follows in the book a description of the different kinds of radiations). Granted that this language might be objected to in a text-book, it makes the author's meaning clear to the reader, and is obviously permissible in a book of this character.

In other words, the author seeks to convey certain ideas of modern chemistry to readers, many of whom have but limited chemical knowledge, and he does it successfully, even if the language is not that of scientific precision.

Regarding the criticism that Ota "accomplished nothing more remarkable than the measurement of the freezing points of solutions," it is to be recalled that these measurements opened up the solvate theory.

Nor do we think it remarkable that an author, in suggesting the consultation of some fuller work on radioactivity, should refer to his own book on the subject, where full references to the literature of radioactivity may be found.

It is unfortunate that in the popularizing of chemistry as well as other sciences, so few who know, write, and so few who write, know; and one reason, I apprehend, why so few who have competent knowledge, translate that knowledge into language for the people, is because they know it is almost impossible so to do, without exposing themselves to just such criticisms as that of Professor Franklin.

"A New Era in Chemistry" gives evidence of being an enthusiastically written labor of love, and is remarkably successful in giving a living bird's-eye view of the development of the chemistry of to-day. As such, I was glad to commend it—perhaps extravagantly—in my review in the *American Chemical Journal.* Had it been more slowly and painstakingly written, it might have presented fewer opportunities for scientific criticism, but I am sure it would have been far less delightful reading.

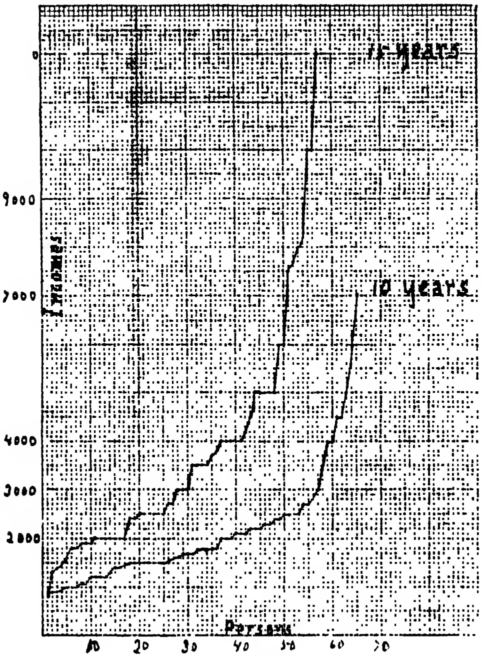
JAS. LEWIS HOWE

DUNE COTTAGE,
CUSHING, MASS.

INCOMES OF COLLEGE GRADUATES TEN AND FIFTEEN YEARS AFTER GRADUATION

SCIENCE for February 4, 1910, printed a statement of the incomes of sixty-seven of the hundred men in the Dartmouth class of '99 the tenth year out of college. At the quindecennial reunion last June the net incomes of fifty-six of the ninty-five now living were recorded. Practically all of the fifty-six were included in the group five years ago. Those from whom the facts were not secured undoubtedly would lower the average for the class somewhat, but the two groups are directly comparable. The figures five years ago were used editorially in at least one metropolitan paper to prove the wasted expense of a college education when the earning capacity ten years after graduation was so small. The present figures show that there is a very rapid rise in

this capacity after ten years. Five years ago there were nineteen men getting fifteen hundred or less, this year only four. Then only seventeen per cent. had more than three thousand dollars and last year a little over fifty per cent. were in this class. Five years ago



the highest man had seven thousand dollars and this time the highest was twelve thousand with two tens. Five years ago the average was \$2,097 and this time \$3,729, with the men at present much more closely massed about the average.

The plat shows the lower line exactly as published five years ago, and the upper line shows the present distribution of incomes.

HERBERT ADOLPHUS MILLER
OBERLIN COLLEGE

SCIENTIFIC BOOKS

The Constitution of Matter. By JOSEPH S. AMES. Houghton Mifflin Co., 1913. 8vo. Pp. x + 242.

This volume represents the 1913 series of lectures, six in number, given at Northwestern University under the N. W. Harris foundation. The purpose of this foundation, as expressed by the donor, "is to stimulate scientific research of the highest type, and to bring the results of such research before students and friends of Northwestern University and through them to the world." It was therefore necessary for Professor Ames, with the above subject, to undertake the extremely difficult task of presenting a true picture of the present status of scientific thought upon the broadest and the most fundamental, though the most dimly discerned, of the fields of science, and at the same time to do it in such a way as to hold the attention of a general audience.

That the lectures actually did command the interest of physicist and layman alike will be testified by all who heard them. Robbed however of the compulsion of Professor Ames's personality I suspect that the printed lectures will make their greatest appeal to the scientist rather than to that type of layman whose taste dictates the popular science of *Harpers, Scribners* and the like. For a careful scientific analysis, such as Professor Ames gives, of the concepts and phenomena which constitute the very foundations of physics, even though divorced, as it is here, from all attempt at mathematical formulation, is something more than the diversion of an idle hour. Indeed many a physicist will ponder long over some of these chapters, and read them more than once, and use them continually for reference as he attempts to put together the rapidly accumulating facts of molecular, atomic and electronic physics into a consistent theory of the constitution of matter.

There are few if any other men whose grasp of both the facts and the theories of physics is sufficiently comprehensive to enable them to discuss with such freshness, thoroughness and insight so many of the problems raised by recent investigations.

Perhaps the most charming feature of the lectures is the clearness and frankness with which Professor Ames reveals his own way of thinking about the problems of atomic and electronic physics and the definiteness of the physical pictures which he calls to his aid. There is no servile restatement of the most striking features of some other physicist's

point of view such as is so characteristic of most popular science writing, but instead a clear presentation of current scientific opinion as it has been incorporated into Professor Ames's own thinking.

The first lecture lays the foundation for the remainder by an admirable and a very discerning historical discussion of the introduction into physics of the concepts of mass, force, the ether, energy, molecules, atoms and corpuscles. Concerning this chapter I would make but two comments: It is a pity that all other writers have not shown as much discrimination in the use of the terms corpuscle and electron. The latter term was introduced into physics in 1891 by G. Johnstone Storey to denote the "natural unit of electricity" *altogether without reference to the inertia which might be associated with it* and it is surely desirable to-day to have some word to denote this idea. *Electron* is obviously the logical word for the purpose. A *negative* electron when associated with the smallest inertia which is ever found to accompany an electron, namely, 1/1830th that of the hydrogen atom, was called by Thomson a corpuscle, and Professor Ames wisely follows this usage. I can not myself be quite so enthusiastic about the statement that "a system has potential energy if it is in its natural condition" or indeed about the way in which the idea of potential energy is used throughout the first and second chapters, especially throughout the second, which deals primarily with the subject of electromagnetic mass. There is a sentence in one of the later lectures which reads as follows: "There is no word, I think, in our language which is so much used to conceal ignorance as 'heat,' and no word about which there is so much confusion of ideas as 'temperature.'" I should like to insert in each clause "*except the word energy.*" The third lecture treats together the newest and the oldest of the departments of physics, namely, radioactivity and gravitation, the former quite briefly (excellent judgment again), the latter quite at length but with a freshness and power which is born only of a very thorough and profound knowledge of original sources.

The fourth, fifth and sixth lectures are the finest and most stimulating of the course. They deal respectively with (4) the problems of radiation, (5) the electron theory of conduction, thermoionics and magnetism, (6) models of atoms and fundamental concepts of nature. These chapters represent I think the best general discussion which has appeared in English of the big problems which the researches of the past two decades have presented to modern physics.

R. A. Millikan

Ryerson Laboratory,
University of Chicago

The Chemistry of Cattle Feeding and Dairying. By J. Allan Murray. London, Longmans, Green and Co. 1914. Octavo. Pp. 343.

This book discusses briefly (1) the constituents of plants and animals, (2) the nutritive requirements of animals, (3) feeding stuffs and (4) dairy chemistry. The treatment is, in the main, elementary in character. The distinctive feature is an attempt to break away from the Wolff and the Kellner feeding standards, especially in recognition of the fact that the nutritive requirements of animals do not vary directly as the live weight. The point of view is rational, and the tentative formulæ suggested for the separate computation of food requirements for maintenance, labor, milk production, growth and fattening constitute a notable step in a direction in which progress is much to be desired. The discussion of the chemistry of the subject is generally satisfactory.

The author's statements regarding the functions of the mineral elements, and regarding other matters of physiology and histology, are frequently lacking in discrimination. We quote a few such passages:

Page 8: "The ingredients of the ash are not 'mineral.' They are just as much organic matter as the fats or proteins."

Page 9: "It is probable, however, that the chlorides naturally present in the food of herbivora are sufficient to provide all the hydrochloric acid required."

Page 10: "Potassium compounds appear to be of minor importance in the economy of animals. They occur in the blood of all herbivora as a necessary consequence of their presence in the food."

"Potassium compounds . . . form nearly one quarter of the ash of milk. . . . A farmer producing milk, therefore, will find it profitable to use potash manures unless his soil is naturally well stocked with that ingredient. Practically the whole of the potash in the food, except what is exported in the milk, is returned to the land in the droppings of the animals."

Page 13: Referring to the ingredients of the ash the author says: "From the point of view of the practical cattle feeder they are all unimportant, inasmuch as they are always present in the natural food of the animals."

Page 15: "Carbohydrates are produced by animals only in insignificant quantities."

Page 46: "Fats do not form part of the tissues of plants as they do in animals."

Page 93: "The composition and properties of lactochrome . . . are quite unknown."

Page 99: "The collagen (of bones) acts as a kind of cement and holds the particles of mineral matter together."

Page 104: "No means is known by which this difficulty (the presence of metabolic nitrogen in the feces) can be overcome; but the amount of such ingredients is probably small and approximately constant. In practise it is ignored."

Page 109: In discussing the absorption of nutrients and their passage into the blood and to the heart, the liver is not mentioned.

Page 132: "This amount (the maintenance requirement of digestible protein) may be estimated, as previously shown, from the amount of nitrogen in the urine which contains all of the nitrogenous products of metabolism."

Much of the matter relative to foods is of local significance and not applicable to the United States, thus (page 255), referring to the storage of ensilage in a silo, "the expense is greater than that involved in the waste of fodder when the silage is made in a stack." "When the expense of a built silo or the alternative loss due to charring at the outside of a stack is added to the losses due to fermentation, it is obvious that silage making is not a profitable method of preserving fodder; and is now rarely practised in this country."

E. B. FORBES

AGRICULTURAL EXPERIMENT STATION,
WOOSTER, O.

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (Vol. 15, No. 3) of the *Transactions of the American Mathematical Society* contains the following papers:

H. F. Blichfeldt: "A new principle in the geometry of numbers, with some applications."

F. R. Sharpe and C. F. Craig: "An application of Severi's theory of a basis to the Kummer and Weddle surfaces."

L. P. Eisenhart: "Transformations of surfaces of Voss."

F. R. Sharpe and Virgil Snyder: "Birational transformations of certain quartic surfaces."

G. M. Green: "One-parameter families of curves in the plane."

G. A. Bliss and A. L. Underhill: "The minimum of a definite integral for unilateral variations in space."

L. D. Cummings: "On a method of comparison for triple-systems."

W. R. Longley: "An existence theorem for a certain differential equation of the nth order."

THE June number (Vol. 20, No. 9) of the *Bulletin of the American Mathematical Society* contains: Report of the spring meeting of the society at Chicago, by H. E. Slaught; "On ovals," by Tsuruichi Hayashi; "On the class of doubly transitive groups," by W. A. Manning; Review of Christoffel's Gesammelte mathematische Abhandlungen, by L. P. Eisenhart; Review of Vivanti's Esercizi di Analisi infinitesimale and Dingeldey's Sammlung von Aufgaben zur Anwendung der Differential- und Integralrechnung, by R. C. Archibald; "Shorter Notices;" Heiberg's Archimedis Opera Omnia, volume II., Heath-Kliem's Archimedes' Werke, and Mænnchen's Geheim-

nisse der Rechenkünstler, by D. E. Smith; Study's Konforme Abbildung einfach-zusammenhängender Bereiche, by Arnold Emch; "Notes;" and "New Publications."

The July number of the *Bulletin* contains: Report of the April meeting of the society in New York, by F. N. Cole; Report of the twenty-fifth regular meeting of the San Francisco section, by Thomas Buck; "The ratio of the arc to the chord of an analytic curve need not approach unity," by Edward Kasner; "A Mersenne prime," by R. E. Powers; Review of Osgood's Lehrbuch der Funktionentheorie, by E. B. Van Vleck; "Notes;" "New Publications;" Twenty-third annual list of published papers; and Index of Volume 20.

The October number (Vol. 21, No. 1) of the *Bulletin* contains: "On a small variation which renders a linear differential system incompatible," by Maxime Bôcher; "The smallest characteristic numbers in a certain exceptional case," by Maxime Bôcher; "On approximation by trigonometric sums," by T. H. Gronwall; "Note on the roots of algebraic equations," by R. D. Carmichael and T. E. Mason; "Remarks on functional equations," by A. R. Schweitzer; "Shorter Notices;" Hadamard's Leçons sur le Calcul des Variations, Tome premier, by E. R. Hedrick; Boutroux's Principes de l'Analyse mathématique, Tome premier, by J. B. Shaw; Blumenthal's Principes de la Théorie des Fonctions entières d'Ordre infini, by G. D. Birkhoff; Riesz's Systèmes d'Equations linéaires à une Infinité d'Inconnues, Bowley's General Course of Pure Mathematics from Indices to Solid Analytic Geometry, and Fabry's Démonstration du Théorème de Fermat, by R. D. Carmichael; Silberstein's Vectorial Mechanics, by E. B. Wilson; "Notes;" and "New Publications."

SPECIAL ARTICLES

VITALITY AND INJURY AS QUANTITATIVE CONCEPTIONS

Although a fundamental conception of physiology, the idea of vitality has not been very precisely formulated. This is not only unfortunate from a theoretical standpoint, but it also has practical disadvantages. The physiologist often finds that the validity of his conclusions depends on selecting material of normal validity for his experiments. When he examines organisms for this purpose he is too apt to find that all the tests of vitality which he employs are uncertain or that at best they lack the precision necessary for quantitative work.

An accurate method of measuring vitality seems therefore to be needed not only for more precise formulation of the conception itself, but also for practical purposes.

The investigations of the writer lead to the conclusion that the vitality of a tissue is so dependent on the maintenance of its normal permeability that we may employ the permeability of protoplasm as a sensitive and reliable indicator of its vitality. We may therefore obtain an accurate measure of the vitality of a tissue by carefully measuring its permeability.

This may be accomplished by determining the electrical resistance of living tissues. This method is rapid and convenient for practical use. It may be applied to pieces of detached tissue or to the intact organism.

The writer began the use of this method by cutting disks from the fronds of the marine alga, *Laminaria saccharina,* and measuring their electrical resistance in a manner which has already been described.[1] Subsequently it was found possible to measure the resistance of intact fronds both of *Laminaria* and of other plants by methods which will be described in detail in a future publication.

As the result of his experience with this method the writer concludes that it is often very difficult to judge of the condition of an organism by its appearance. The tissues on which experiments have been made were found to be capable of losing much of their vitality without betraying it in any way by their appearance. (This was particularly the case with eel grass, *Zostera,* which retained its normal green color and appearance for some days after

[1] Science, N. S., 35: 112, 1912.

electrical measurements showed it to be dead.) On the other hand, material of doubtful appearance often turned out to be much better than that which looked to be in sound condition. It seems quite possible that this will be found to be the case with other organisms when quantitative tests are applied.

Material collected in a restricted locality and examined as soon as taken from the ocean gave a very uniform resistance. The same number of disks were used in each experiment, and as the disks were packed together like a roll of coins the length of the roll gave an accurate measure of the average thickness of the disks. To make the comparison as accurate as possible disks of the same average thickness were used in all the experiments. Under these circumstances the resistance at 18° C. did not vary much from 1,300 ohms. For example, in a series of determinations of ten different lots of tissue the highest reading was 1,320 ohms and the lowest 1,285 ohms. These lots of tissue were allowed to remain in the laboratory under different conditions. Some were placed in running salt water while others were allowed to stand in still salt water in pans of various sizes. Some of these were placed in direct sunlight (where the temperature rose to an injurious point) while others were kept in a cool place and sheltered from direct sunlight. At the end of twenty-four hours there was no difference in the appearance of these lots, but their electrical resistance varied from 400 ohms to 1,320 ohms. All were then placed side by side in the same dish. Those with the lowest resistance were the first to die, as was shown by the fact that their resistance fell to the death point (about 330 ohms) and became stationary. The others died in the order indicated by their electrical resistance.

Determinations of the resistance made it evident that in no case did visible signs of death make their appearance until twenty-four hours after death occurred, and subsequent experiments showed that in some cases (especially at low temperatures and in the presence of certain reagents) they may not appear until several days after death.

It was found that material from one locality showed a low resistance and subsequent examination showed that it was contaminated by fresh-water sewage. The appearance of the plants was not such as to lead to their rejection for experimental purposes. They did not survive as long in the laboratory as plants of normal resistance taken from the other localities.

It may be taken for granted that vitality, whatever else it may signify, means ability to resist unfavorable influences. When organisms which are of the same kind, and similar in age, size and general characters, are placed under the same unfavorable conditions, the one which lives longest may be said to have the greatest vitality;[2] the one which lives next longest may be rated second in this respect, and so on. Determination of the electrical resistance of these individuals enables us to predict at the outset which will live longest, which next longest, and so on through the entire group.

Moreover, we find that all influences which impair vitality lower the electrical resistance. It is therefore obvious that determinations of electrical resistance afford a means of measuring vitality and in the course of an extensive series of experiments it has been found that this method may be relied upon to give accurate results.[3]

[2] It might be expected that this individual would also excel in other respects. A discussion of these is unnecessary from our present standpoint: in so far as they can be quantitatively treated they form proper material for a supplementary investigation.

[3] It is evident that the most accurate comparisons will be secured when the tissues or organisms are closely similar in structure, for variations in structure may cause variations in electrical resistance. To compare tissues or organisms which differ in structure (or which for any other reason differ in the absolute number of ohms which expresses their normal resistance) we may use the fall of electrical resistance in a given time under unfavorable conditions (expressed as percentage of the normal net resistance, as suggested below in the discussion of injury) or we may use the speed of recovery from injury of a definite degree. The fall of resistance need not proceed beyond the point at which complete recovery is pos-

The fact that determinations of electrical resistance afford an accurate measure of vitality enables us to attach the same sort of quantitative significance to normal vitality as we attach to normal size or to normal weight. For this purpose we may construct a variation curve and determine the mode in the usual way.

There is no reason to suppose that the vitality of an individual organism is constant any more than its weight is. There is probably some fluctuation which usually passes unperceived unless a quantitative method of detecting it exists. The writer finds that some substances which are normally produced in the organism alter its electrical resistance. Certain reagents may produce marked alteration of resistance without permanent injury. For example, tissue of *Laminaria* having a resistance of 1,020 ohms was placed in NaCl .52 M, which had the same conductivity as the sea water; in the course of a few minutes the resistance fell to 890 ohms, but on being replaced in sea water it rose in the course of a few minutes to the normal amount, where it remained. This was repeated on the same piece of tissue for several days without any sign of permanent injury.[4]

It is therefore evident that considerable fluctuations in vitality may occur without leaving any permanent record.

The determination of electrical resistance makes possible a quantitative treatment of injury. It is obvious that this is as important as a quantitative treatment of vitality. The degree of injury may be defined as the amount[5] by which the resistance falls below the normal net resistance. Temporary injury may be defined as that from which the organism fully recovers, while permanent injury may be defined as that which is not followed by complete restoration of the normal resistance.[6]

From a theoretical standpoint it may be desirable to use in place of the resistance its reciprocal, the conductance.

We may now turn our attention to the significance of this method of measuring vitality and injury. Since the conductivity of the tissue is a measure of the permeability of the protoplasm to ions it is evident that in this method the permeability of the protoplasm is used as an indicator of its vitality. This is in accord with the results of long experience. In doubtful cases it has been customary to determine whether a cell was alive or dead by its ability to contract in a plasmolyzing solution or to resist staining by certain dyes. The diffusion of certain substances out of the cell has long been recognized as a sign of death. All of these are tests of permeability. These criteria have been successfully employed in cases where there was nothing in the appearance of the cell to indicate whether it was alive or dead.

The writer has found that the method of plasmolysis may be utilized to distinguish not only between living and dead cells, but also between cells of normal vitality and those in which vitality has been impaired by certain reagents. In these experiments the reagent was not allowed to act long enough to produce permanent injury.

Lack of space renders it impossible to go into the details of these investigations, but attention may be called to experiments already published which may be interpreted from this point of view.[7] These experiments show that cells recover more quickly from plasmolysis (and consequently have greater permeability) in solutions in which their vitality is impaired.

For example it was found that in sea water suitably diluted a cell of *Spirogyra* when

sible and after recovery the material may be used for experimental purposes. In this way individuals of different species or unlike tissues of the same individual may be compared with respect to vitality. From a theoretical standpoint it may be desirable to use in place of the resistance its reciprocal, the conductance.

4 SCIENCE, N. S., 36, 350, 1912.

5 This is best expressed as percentage of the normal net resistance; the net resistance is found by subtracting the resistance of the apparatus.

6 The term injury as used by the writer in previous papers is synonymous with the term permanent injury as here defined.

7 SCIENCE, N. S., 34, 187, 1911.

plasmolyzed to a moderate degree[8] recovered in about twenty-four hours. The *Spirogyra* lives and maintains its normal permeability indefinitely in such dilute sea water.

When placed in a solution of pure NaCl .4 M the vitality of the cell is rapidly impaired and it dies in the course of two or three hours.[9] If such a cell be plasmolyzed by .4 M NaCl to a moderate degree[8] it recovers in the course of half an hour. Since the permeability is inversely proportional to the time of recovery, it is evident that the NaCl impairs the vitality of the cell and at the same time increases its permeability.[10] The two processes go hand in hand. The permeability continues to increase until death occurs, when the cell becomes completely permeable.

These experiments were repeated with a variety of reagents and were afterward confirmed in every detail by the method of determining electrical resistance.

As the result of these and other experiments we may say that the permeability is greatly affected by changes in the composition of the salt solution in which the cell is placed. Normal permeability is best preserved in solutions in which the proportions of salts are approximately the same as in sea water and normal vitality is also maintained longest in these solutions. In general we find that vitality and permeability are affected in exactly the same way by various kinds of electrolytes.

This principle may be applied much more generally. The writer finds that all substances (whether organic or inorganic) and all agents (such as excessive light, heat, electric shock, mechanical shock, partial drying, lack of oxygen, etc.) which alter the normal permeability of the protoplasm shorten the life of the organism. This is equally true whether the alteration consists in an increase of permeability, or in a decrease of permeability (followed by an increase) as is the case when certain reagents (such as $CaCl_2$) are applied.[1] This is a very striking fact and its significance in the present connection seems to be clear and unmistakable. It shows in the most convincing manner that permeability is a delicate and accurate indicator of vitality.

We are unable to say why there is such an intimate connection between vitality and permeability. It is evident that permeability may control metabolism by regulating the osmosis of various substances, and conversely that metabolism may affect permeability. What is needed is not more speculation in this direction, but a careful analysis of the factors which control permeability. If we are successful in determining what these factors are we may hope to arrive at a more satisfactory formulation, in physico-chemical terms, of our conception of vitality as well as of that of injury.

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8 This degree is a definite one. It was usually chosen as the condition in which the protoplast just touched the end walls.

9 This applies only to the species of *Spirogyra* used in these experiments: some species may be more resistant while others are much more sensitive and are killed in less than ten minutes.

10 In other solutions in which vitality is more rapidly impaired the recovery from plasmolysis is also more rapid and we must conclude that the permeability is proportionately increased.

SOIL ACIDITY AND METHODS FOR ITS DETECTION

THE so-called "acid" soils are peculiar in that a solution obtained by shaking such soils with water will be found, except in rare cases, to be absolutely neutral toward litmus paper. However, if the test paper be brought into direct contact with the soil particles themselves, a very sharp acid reaction will be obtained. These acid soils possess another peculiar property in that if shaken with a solution of some neutral salt such as sodium chloride, an appreciable amount of a soluble acid will be found to be set free.

Two theories have been advanced to explain these properties. The older and perhaps still the most generally accepted theory is the humic acid theory. This theory assumes that there are present in the acid soils, as the result of the decomposition of animal and vegetable matter, some very insoluble organic acids called humic acids. These are supposed to be definite

compounds which react with litmus when the test paper is brought into direct contact with the solid particles and which enter into double decomposition with any salt with which they come in contact liberating the corresponding soluble acid. This latter assumption is rather absurd in the light of our modern ideas of chemistry. The law of mass action is probably one of the most generally accepted laws of chemistry and if we are to accept this law, it is hard to conceive of any acids, as insoluble as these humic acids must be, entering into a double decomposition with a neutral salt such as sodium chloride and setting free such a strong acid as hydrochloric acid. Much experimental work has been done on these humic acids, most of this work consisting of attempts to isolate the acids in a pure form. Experimenters claim to have done this and have even gone so far as to assign definite chemical formulæ to some half dozen of these acids. However, no two experimenters seem able to agree on these formulæ.

Since Van Bemmelen's work on colloids and adsorption, a newer and certainly far more reasonable theory has been put forward to explain the action of acid soils. It is well known that the coagulation of a colloid by a solution of a neutral salt is accompanied by the adsorption of one or other of the ions. If the colloid be electro-negative, it will adsorb the positively charged ion of the salt setting free a corresponding amount of acid. If it is electro-positive, it will adsorb the negatively charged ion setting free a corresponding amount of the base. In the case of the soils, there is present much negatively charged colloidal matter. If deficient in basic material, this colloidal matter is present in a deflocculated condition and is capable of adsorbing the base from any neutral salt with which it comes in contact. Thus if the soil particles are brought into contact with blue litmus, it adsorbs the base of the blue litmus salt leaving the red acid dye on the paper. When shaken with a solution of a neutral salt, the basic portion of the salt is adsorbed leaving a corresponding amount of acid in solution. If the salt used be sodium chloride, the sodium hydroxide is adsorbed and hydrochloric acid liberated.

The acid soils may be divided into two types: first, those found in sandy upland regions, and second, those found in peat or muck lands. The first type has been thoroughly investigated by the writer[1] in the chemical laboratory of the Michigan Agricultural Experiment Station, and he has been able to show that not only is the peculiar behavior of these soils not due to the presence of any true organic acids, but that it is not due to organic matter at all. It was found that soils in which all the organic matter had been destroyed, still retained their acid properties, these properties being due to the presence of colloidal substances, probably hydrated silicates of iron and aluminum. The second type of soils have been investigated by Baumann and Gully[2] who have shown that in the peat soils the acid properties are due to the colloidal matter of the cell covering of the hyalin sphagnum cells.

The remedy for soil acidity is well known. If a soil be treated with lime (either calcium carbonate or calcium hydroxide), the acid properties are destroyed and the soil restored to its former condition of fertility. Many methods have been devised for the determination of the degree of acidity of the soil or, as it is often called, the "lime requirement" of the soil. Most of these methods are based on the old humic acid theory in spite of the fact that this theory has been so thoroughly discredited of late. Such a method was recently described by E. Trugg.[3] The method consists of treating the soil with calcium chloride, zinc sulphide and water. The soil, if acid, reacts with the zinc sulphide liberating hydrogen sulphide which can be detected by means of lead acetate paper. As to the use of the calcium chloride, we will quote from the article:

> The calcium chloride is added to make the test more sensitive. It reacts with the comparatively insoluble soil acids and forms a small amount of

[1] *Jour. of Phys. Chem.*, 18, 355 (1914).

[2] *Mitteilung der K. Boyr. Moorkulturanstalt*, 1910, 31–156.

[3] Science, 50, 246 (1914).

hydrochloric acid which readily liberates hydrogen sulphide from zinc sulphide.

This statement brings out very clearly the absurdity of the position of those who accept the humic acid theory. These humic acids are supposed to be strong enough and soluble enough to liberate hydrochloric acid from calcium chloride, but not strong enough or soluble enough to liberate hydrogen sulphide from zinc sulphide. It is also suggested that this method be made the basis for a quantitative determination of the lime requirement of the soil. The writer does not believe this possible because he has shown[4] that acid soils do not adsorb equivalent amounts of different ions. A determination of the amount of zinc adsorbed by the soil will not tell us the amount of lime to be applied to the soil. Furthermore it is not possible to use a factor to determine the amount of lime to be used from the quantity of hydrogen sulphide given off, because it has been found that the ratio of the amounts of two different ions adsorbed will vary with the character of the soil used. The ratio of the amount of zinc adsorbed to that of calcium will vary with each different sample of soil depending upon the kind of colloidal matter present. The only sure way to determine the lime requirement of an acid soil is to use the same material in the test as is used in the field for correcting the acidity. This is done in the methods of Veitch and Süchting.

As to the qualitative methods for the detection of soil acidity, it has been found that all kinds of litmus paper are not suitable. In fact, in the chemical laboratory of the Michigan Agricultural Experiment Station, Kahlbaum's litmus paper has been found to be the only one not so thoroughly saturated with alkali as to make it unsuitable for this purpose. This litmus paper is so sensitive that it is necessary to leave it in contact with the soil particles only for a moment or two. In this way it has been found that soils only very slightly acid give a distinct test.

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[4] *Loc. cit.*

A SUGGESTION IN CONNECTION WITH THE STARK-ELECTRIC EFFECT

THE discovery last year of the separation of certain spectrum lines when emitted in an electric field has been followed by a remarkably thorough investigation of the phenomenon by Stark and his co-workers.[1] Hydrogen, helium, lithium, calcium, sodium, magnesium, aluminium, thallium and mercury lines have been examined; but only the diffuse, subordinate series lines of hydrogen, helium and lithium show a separation as great as an angstrom for a field intensity of 10,000 volts per cm. The Stark-electric effect differs from the Zeeman effect in that the various lines of the same series are not equally affected, but, for the same field, the separation increases with the number of the term. Stark emphasizes the complexity of the effect, and gives no law for the relative separation of various lines of the same series, though he suggests that a relation should be sought between the relative change of frequency of the various lines and their term numbers.[2]

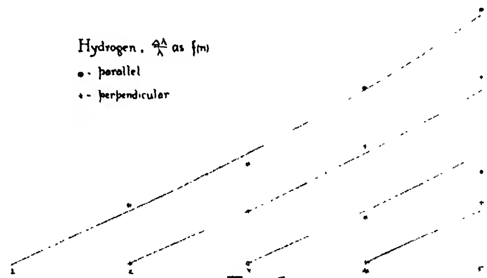

FIG. 1.

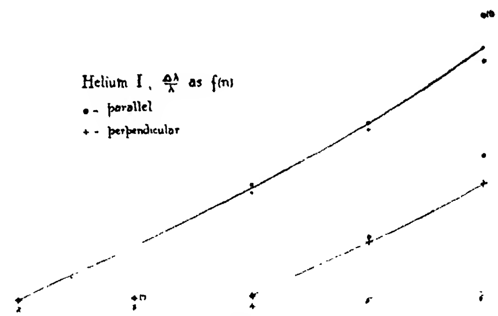

FIG. 2.

[1] *Annalen der Physik*, 43, 965–1047, 1914.

[2] *L. c.*, p. 1033.

From an examination of the data it seems probable to me that the effect is simpler than Stark implies, and that such a relation as he suggests does exist. The relative change of frequency $\Delta n/n$ is equal to $\Delta\lambda/\lambda$, the separation of corresponding, symmetrically placed components divided by the wave-length of the particular line. If we plot this $\Delta\lambda/\lambda$ as a function of the term number, smooth curves drawn through the points are found to agree closely in slope, etc., differing only in the number of the term at which they start. Figs. 1 and 2 show the results for hydrogen and helium I. The numerical data are given in the following table. The numbers in brackets are the term numbers.

$10^8 \times \Delta\lambda/\lambda$ FOR A FIELD OF 28,500 VOLTS PER CM.

Components	Polarization	HeI	HeII	Calc.
Outer	Parallel	(2) 1.00 (3) 0.93	(3) 1.05	0.90
Outer	Parallel	(3) 1.68 (4) 1.91	(4) 2.07	1.86
Outer	Parallel	(4) 2.98 (5) 2.96		2.94
Outer	Parallel	(5) 4.31 (6) 4.77(?)		4.20
Outer	Perpendicular	(3) 0.90 (3) 0.83	(3) 0.93	0.90
Outer	Perpendicular	(4) 1.98 (4) 1.77	(4) 1.85	1.86
Outer	Perpendicular	(5) 3.17 (5) 2.82		2.94
Inner	Parallel	(4) 0.79 (5) 1.00		0.90
Inner	Parallel	(5) 1.55 (6) 2.36		1.86
Inner	Perpendicular	(5) 1.04 (5) 0.91		0.90

Hydrogen differs from the other elements in that the components polarized parallel to the field, and those polarized perpendicular to it lie on different curves.

The smooth curves shown in the figures all correspond to the equation

$$(1) \qquad \frac{\Delta\lambda}{\lambda} \times 10^8 = 0.89\ (n-p) + 0.01\ (n-p)^3,$$

where p is the number of the term where the curve begins in each case.

These constants refer to a field of 28,500 volts per cm. Assuming the separation to be proportional to the field, which Stark proved to be true for the hydrogen series, the equation may be written

$$(2) \qquad \frac{\Delta\lambda}{\lambda E} \times 10^8 = 3.1\ (n-p) + .035\ (n-p)^3,$$

where E is expressed in volts per cm.

The reduced separations, $\Delta\lambda/\lambda$, of the HeI lines agree quite closely with this equation; the deviations in the case of the hyd lines are larger, but both positive and negative. Curves given by Stark for the variation of the separation with the field strength[3] seem to show a greater accuracy for his measurements than these deviations would imply. Yet a simple curve can not be drawn through the points representing the outer components of the hydrogen lines so as to fit them better than that corresponding to the above equation. And in the reproductions given of the original photographs, the lines are heavy and not parallel and do not seem capable of more accurate measurement.

In the case of helium, the separations for lines polarized parallel to the field were consistently found to be greater than for the corresponding lines polarized perpendicularly. If the effect is real, as it seems to be, the constants of the equation would have to be slightly different for the two sets of components.

In the case of lithium, the reduced separations for 38,000 volts agree with the separations for the corresponding lines of helium. When reduced to 28,500 volts they are a quarter less. The measurements are stated by Stark to be less accurate than for helium, so whether the difference is real remains to be proved. At least the relative separations of the different terms of the series are the same.

It should be stated that as regards asymmetry of position and intensity, the corresponding lines of hydrogen and helium apparently do not behave alike. In fact, Stark reports differences in the behavior of lines of the same series. As he suggests, the very complexity of the phenomenon makes it a most promising field in which to search for clues to a knowledge of atomic structure. It may be too soon to find regularities and the agreements noted above may be accidental. But I think not. If not, they suggest that there is something which is common to the atoms of hydrogen and helium, in addition to the presence of electrons in both.

GORDON S. FULCHER

WISCONSIN UNIVERSITY,
July 11, 1914

[3] *L. c.*, p. 997.

SCIENCE

FRIDAY, OCTOBER 9, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT TO THE ANTHROPOLOGICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

A STUDY OF PRIMITIVE CHARACTER

CIVILIZATION and "savagery"—for unfortunately it seems now too late to substitute any term of less misleading suggestion for that word "savagery"—are the labels which we civilized folk apply respectively to two forms of human culture apparently so unlike that it is hard to conceive that they had a common origin—our own culture and that other, the most primitive form of human culture, from which, at some unknown and distant period, our own diverged. But, assuming one common origin for the whole human race, we anthropologists can but assume that at an early stage in the history of that race some new idea was implanted in a part of these folk, that is in the ancestors of civilized folk which caused these thenceforth to advance continuously, doubtless by many again subsequently diverging and often intercrossing roads, some doubtless more rapidly than others, but all mainly towards that which is called civilization, while those others, those whom we call "savages," were left behind at that first parting of the ways, to stumble blindly, advancing indeed after a fashion of their own, but comparatively slowly and in a quite different direction.

It is easy enough for civilized folk, when after age-long separation they again come across the "savages,"' to discern the existence of wide differences between the two, in physical and mental characteristics, and

[1] Australia, 1914.

in arts and crafts; it is not so easy, it may even be that it is impossible, to detect the exact nature of these differences, especially in the matter of mental characters.

As a rule the occupant of this presidential chair is one who, whether he has seen much of "savages" at close quarters or not, has had much ampler opportunity than has fallen to my lot of comparative study of that great mass of anthropological observations which, gathered from almost every part of the world, has now been recorded at headquarters. I, on the other hand, happen to have spent the better part of my active life in two different parts of the world, remote from books and men of science, but in both of which folk of civilized and of savage culture have been more or less intermixed, but as yet very imperfectly combined, and in both of which I have been brought into rather unusually close and sympathetic contact with folk who, whatever veneer of civilization may have been put upon them, are in the thoughts which lie at the back of their minds and in character still almost as when their ancestors were at the stage of savage culture.

While trying to adjust the mutual relations of wild folk and of folk of civilized stock, I have seen from close at hand the clash which is inevitable when the two meet—a clash which is naturally all the greater when the meeting is sudden. Moreover, having started with a strong taste for natural history, and especially for the natural history of man, and having had much guidance from many anthropological friends and from books, I have perhaps been especially fortunate in opportunity for studying the more natural human animal at close quarters and in his natural surroundings. I have tried, from as abstract and unprejudiced a point of view as possible, to understand the character, the mental and moral attitude, of the natural "savage" as he must have been when civilized folk first found him and, at first without much effort to understand him, tried abruptly to impose an extremely different and alien form of culture on this almost new kind of man.

I venture to claim, though with diffidence, that I may have begun to discern more clearly, even though only a little more clearly than usual, what the primitive man, the natural "savage"—or, as he might more accurately be described, the wild man—was like; and it seemed possible that an attempt to bring together a picture—it can hardly be more than a sketch—of the mentality and character of some one group of people who had never passed out of the stage of "savagery" might be interesting and practically useful, especially if it proves possible to disentangle the more primitive ideas of such people from those which they subsequently absorbed by contact, at first with other wild, but less wild, folk, and later with civilized folk; and that a further study of the retention by these folk of some of their earlier habits of thought during later stages in their mental development might suggest a probable explanation of certain of their manners and customs for which it is otherwise hard to account.

The attainment of some such understanding is, or should be, one of the chief objectives of the practical anthropologist, not merely for academic purposes, but also for the practical guidance of those who in so many parts of our Empire are brought into daily contact with so-called "savages."

Perhaps hardly anywhere else in the world would it be possible to find better opportunity and more suitable conditions for such a study as I now propose than in the tropical islands of the South Seas. The ancestors of these islanders, while still in

purely "savage" condition, must have drifted away from the rest of the human race, and entered into the utter seclusion of that largest of oceans, the Pacific, covering as it does more than a third of the surface of the globe, long before the first man of civilized race, Balboa, in 1513, from the Peak in Darien, set eyes on the edge of what he called "the Great South Sea," before Magellan, in 1520, forced his way into and across that same sea, which he called the Pacific, and certainly long before civilized men settled on any part of the shore of that ocean, *i. e.*, in 1788, at the foundation of Australia. For when first studied at close quarters by civilized folk from Europe, which was not till after the last-named event, these South Sea "savages" had been in seclusion during a period sufficiently long—and certainly no short period would have sufficed for such an effect—not only for them all to have assumed characters, cultural and even physical, sufficient to distinguish them from all other folk outside the Pacific, but also for them to have split up into many separate parties, probably sometimes of but few individuals, many of which had drifted to some isolated island or island-group, and had there in the course of time taken on further well-marked secondary differences.

It will probably now never be discovered when, how often, and from what different places the ancestors of these folk reached the Pacific. It is quite possible that they entered again and again, and were carried by winds and currents, some from west to east and some in the reverse direction, many perishing in that waste of waters, but some reaching land and finding shelter on some of that great cloud of small islands which lie scattered on both sides of the equator and nearly across that otherwise landless ocean.

Of the folk who in those old times thus drifted about and across the Pacific, the most important, for the part which they played in the story which I am endeavoring to tell, were the two hordes of "savages" now known respectively as Melanesians and Polynesians. Without entering deeply into the difficult subject of the earlier migrations of these two hordes, it will suffice here to note that, towards the end of the eighteenth century, when European folk at last began to frequent the South Sea Islands, and when consequently something definite began to be known in Europe about the islanders, certain Melanesians, who had probably long previously drifted down from north-westward, were found to be, and probably had long been, in occupation of the exceptionally remote and isolated Fiji Islands; also that, long after this Melanesian occupation of these islands, and only shortly before Europeans began to frequent them, several bodies of Polynesians, who had long been in occupation of the Friendly or Tongan Islands, lying away to the east of Fiji, had already forced or were forcing their way into the Fijian Islands.

The meeting in Fiji of these two folk, both still in a state of "savagery," but the Polynesians much further advanced in culture than the Melanesians, at a time before European influence had begun to strengthen in those islands, affords an exceptionally good opportunity for the study of successive stages in the development of primitive character, especially as the two sets of "savages" were not yet so closely intermingled as to be indistinguishable—at least in many parts of Fiji. It is unfortunate that the earliest European visitors to Fiji were not of the kind to observe and to leave proper records of their observations.

The earlier, Melanesian, occupants of Fiji had to some extent given way, but by no means readily and completely, to the

Polynesian invaders. The former, not only in the mountain fastnesses difficult of access, but also in such of the islets as the local wind and weather conditions made difficult of access, retained their own distinct and simpler culture, their own thoughts, habits and arts, long after the Polynesians had seized the more important places accessible to the sea, and had imposed much of their own more elaborate (but still "savage") culture on such of the Melanesians' communities as they had there subjugated and absorbed.

The social organization throughout Fiji remained communistic; but in the purely Melanesian communities the system was purely democratic (*i. e.*, without chiefs), while in the newer mixed Polynesian-Melanesian communities—as was natural when there had been intermingling of two unequally cultured races—there had been developed a sort of oligarchic system, in which the Melanesian commoners worked contentedly, or at least with characteristic resignation, for their new Polynesian chiefs.

Alike in all these communities custom enforced by club-law prevailed; but in the one case the administrative function rested with the community as a whole, while in the other it was usurped by the chiefs.

Though we are here to consider mainly the ideas, the mentality, of these people, it will be useful to say a few preliminary words as to their arts and crafts. The Melanesians during their long undisturbed occupation of the islands had undoubtedly made great progress, on lines peculiar to them, especially in boat building, in which they excelled all other South Sea islanders, in the making of clubs and other weapons, and in otherwise using the timber, which grew more abundantly, and of better quality, in their islands than elsewhere. Meanwhile the Polynesians, in their earlier homes and long before they reached Fiji, had developed, in very high degree, corresponding but different and much more elaborate arts (and ideas) of their own. But, as we know from Captain Cook, the Polynesians, despite their own higher culture, from their Tongan homes, greatly admired and appreciated the special craftsmanship of the Fijians, and it was indeed this admiration which attracted the former from Tonga to Fiji; and when the Polynesians had gained footing in the Fijis they—quite in accordance with human nature—were inclined, for a time at least, to foster the foreign Fijian arts—if not Fijian ideas—rather than replace these by their own arts; and before the struggle, both physical and cultural, between the two sets of "savages" had gone far it was interrupted, and more or less definitely arrested, by the arrival and gradual settlement of the still more powerful, because civilized, white folk from the western world.

In turning to the earlier (Melanesian) occupants of Fiji, and especially to the less advanced of these, to find the traces of which we are in search of the more primitive habit of thought, it must not be forgotten that even at the stage at which we begin to know about them they had made considerable advance, in their ideas as well as in their arts and crafts. They still used their most primitive form of club, but also made others of much more elaborated form; so, though the ideas which lay at the basis of their habit of thought were of very primitive kind, they had acquired others of more complex character.

Before going further may I say—and I sincerely hope that the suggestion will not be misunderstood—that in the difficult task of forming a clear conception of the fundamental stock of thought which must have guided the conduct of the more primitive folk we must constantly bear in mind the parallelism (I do not mean necessary iden-

tity of origin) between the thoughts of the earliest human folk and the corresponding instincts (as these are called) noticeable in the case of some of the higher animals? I am particularly anxious not to be misunderstood; the suggestion is not that even the most primitive human folk were mentally merely on a par even with the higher animals, but that many, perhaps most, of the ways of thought that guided the primitive man in his bearing towards the world outside himself may be more easily understood if it is once realized, and afterwards remembered, that the two mental habits, however different in origin and in degree of development, were remarkably analogous in kind.

A similar analogy, in respect not of thoughts but of arts, may well illustrate this correspondence between the elementary ideas of men and animals. The higher apes occasionally arm themselves by tearing a young tree up by the roots and using the "club" thus provided as a weapon of offense and defense against their enemies. Some of the primitive South Sea islanders did—nay, do—exactly the same, or at any rate did so till very lately. The club—the so-called *malumu*—which the Fijian, then and up to the much later time when he ceased to use a club at all greatly preferred to use for all serious fighting purposes was provided in exactly the same way. *i. e.*, by dragging a young tree from the ground, and smoothing off the more rugged roots to form what the American might call the business end of the club. But though the Fijian, throughout the period during which he retained his own ways, used and even preferred this earliest form of club, he meanwhile employed his leisure (which was abundant), his fancy, and his ingenuity, in ornamenting this weapon, and also in gradually adapting it to more and more special purposes, some of the later of which were not even warlike but were ceremonial purposes, till in course of time each isolated island or group of islands evolved clubs special to it in form, purpose and ornament, and the very numerous and puzzlingly varied series of elaborate and beautiful clubs and club-shaped implements resulted. It seems to be in power of improvement and elaboration that lies the difference between men-folk and animal-folk.

Something similar may be assumed to have brought about the evolution of the ideas of these islanders. Starting with a stock of thoughts similar in kind to the instincts of the more advanced animals, the human-folk—by virtue of some mysterious potentiality—gradually adapted these to meet the special circumstances of their own surroundings, and in so doing ornamenting these primitive thoughts further in accordance with fancy.

In the Fiji Islands this process of cultural development was probably slow during the long period while the Melanesians, with perhaps the occasional stimulus afforded by the drifting in of a little human flotsam and jetsam from other still more primitive folk, were in sole occupation; yet it must have been during this period and by these folk that the distinctively Fijian form of culture was evolved. But the process must have been greatly accelerated, and at the same time more or less changed in direction, by the incoming of the distinct and higher Polynesian culture, at a time certainly before, but perhaps not very long before, the encroachment of Europeans.

In order to realize as vividly as possible what were the earlier, most elementary, thoughts on which the whole detail of his subsequent "savage" mentality was gradually imposed, it is essential for the time being to discard practically all the ideas

which, since the road to civilization parted from that on which savagery was left to linger, have built up the mentality of civilized folk; it is essential to try to see as the most primitive Fijian saw and to conceive what these islanders thought as to themselves and as to the world in which they found themselves.

It seems safe to assume that the primitive man, absolutely self-centered, had hardly begun to puzzle out any explanation even of his own nature, still less of the real nature of all the other beings of which he must have been vaguely conscious in the world outside himself. To put it bluntly, he took things very much as they came, and had hardly begun to ask questions.

He was—he could not but be, as the lower animals are—in some vague way conscious of himself, and from that one entirely self-centered position he could not but perceive from time to time that other beings, more or less like himself, were about him, and came more or less in contact with him.

The place in which he was conscious of being appeared to him limitless. He did not realize that he could move about only in the islet which was his home, or perhaps even only in a part of a somewhat larger, but according to our ideas still small, island; if other islets were in sight from that on which he lived, these also would be part of his world, especially if—though such incidents must have been rare—he had crossed to, or been visited by strangers from, those islands—islands which lay between his own home and that which he spoke of as *wai-langi-lala* (water-sky-emptiness) and we speak of as the horizon. To him the world was not limited by any line, even the furthest which his sight disclosed to him. Rarely, but still sometimes, strangers had come from beyond that line. Perhaps too he had some time heard that his ancestors had come from the somewhere which seemed beyond. Again his ancestors of whom he had heard, and even some of the contemporaries whom he had seen, though no longer with him except occasionally during his dreams in bodily form, were somewhere, somewhere beyond that line of sight. Even he himself (in what were his dreams, as we say, but to him were part of his real life) habitually went beyond the line, and, as far as his experience had gone, returned each time to the island home.

Moreover, he did not doubt that this limitless region in which it vaguely seemed to him that he, and innumerable other beings, moved, extended not merely along what we speak of as the surface of the globe, but also, and equally without any intervening obstacle, up into the infinite space above and beyond the sky. In short, to this primitive man the world, though the part of it to which he had actual access was so small, was limitless.

The thoughts of the dweller in this vague world, as to himself and as to the other beings of which from time to time he became conscious, must have been correspondingly indefinite.

He was, to a degree almost if not quite beyond our power of conception, a spiritualist rather than a materialist; and it is essential to get some idea of the extent and manner of his recognition of spiritual beings—and his corresponding non-recognition of things material.

In passing I here disclaim, for myself at least, the use of the misleading word "belief" in speaking of the ideas of really primitive man—as, for instance, in the phrase the "belief in immortality." Possibly primitive men of somewhat more advanced thought, though not yet beyond the stage of "savagery," may have "believed" in spirits, in immortality, and so on; but it

seems to me that at the earlier stage there can hardly have been more than recognition (admittedly very strong recognition) of spiritual beings, and non-recognition of any beginning or ending of these spirits.

To return from this digression, Sir E. B. Tylor long since gave currency to the very useful word "animism" as meaning "the belief in spiritual beings," and this has been taken to mean that animism was the initial stage, or at any rate the earliest discoverable stage, of all religion. The primitive Fijian was certainly a thorough-going animist, if his extraordinarily strong but vague recognition of spiritual beings suffices to make him that; but I do not think that the ideas of that kind of the primitive "savage"—or, say, of the most primitive Fijian—before his ideas had been worked up into somewhat higher thought, during the long period while he was secluded in his remote islands and before the advent of the Polynesians, had developed far enough to constitute anything which could be called "religion," though doubtless they were the sort of stuff which, had these folk been left to themselves, might, probably did, form the basis of the "religion" towards which they were tending.

Practically all human beings—savage and civilized alike—and, though in lower degree, even animal-folk, have in some degree recognized the existence of some sort of spiritual beings. The point then seems to be to discover what was the nature of the spiritual beings which the primitive Fijian recognized but without understanding.

Anthropologists have recently defined, or at least described, several kinds of spiritual beings as recognized (even here I will not use the word "believed") by more or less primitive folk. There is, first, the soul, or the separable personality of the living man or other being; secondly, the ghost, or the same thing after death; thirdly, the spirit, which is said to be a soul-like being which has never been associated with a human or animal body; and, fourthly, there is, it appears, to be taken into consideration yet another kind of spiritual being (or something of that nature) which is the life of personality, not amounting to a separable or apparitional soul, which, it has been supposed, some primitive folk have attributed to what we call "inanimate things."

It seems, though I say this with all due deference, that this identification and naming of various kinds of spiritual beings, though it may hold good of animism at a higher stage, does not fit the case of the more primitive animist (say, that of the Melanesian in the very backward state in which, as far as we know, he first reached Fiji), for presumably he had not as yet recognized nor differentiated between the various kinds just enumerated. He recognized something which may be called the "soul," which was the separable personality of the living man or other being. But he did not recognize—perhaps it would be better to say that he had not yet attained to recognition of—the ghost, or the same thing after death; for he had not even recognized any real break, involving change, at death. Nor, as I think, did he recognize a spirit, *i. e.,* a soul-like being which had never been associated with a human or animal body; for he had no idea of any spiritual being which did not, or could not, on occasion associate itself with a human, animal or other material body, nor seemingly had he reached the stage, labelled *animatism,* in which he would have attributed life and personality to things (which I take to mean things which are to us inanimate).

All that the most primitive man would recognize would be that he himself—the essential part of him—was a being (for

convenience and for want of a better name it may be called "soul") temporarily separable at any time from the material body in which it happened to be, and untrammeled—except to some extent by the clog of the body—by any such conditions as time and space; he had found no reason to think that in these respects the many other beings of which from time to time he became aware (whether these were what we should class as men, other animals, or the things which we speak of as inanimate, such as stocks and stones, or bodiless natural phenomena, such as winds) differed from himself only in the comparatively unimportant matter of bodily form; moreover, it seemed to him that, as he himself could to some extent do all these, the other beings, and some perhaps even more easily, were able to pass from one body to another.

He felt that these "souls" were only temporarily and more or less loosely attached to the particular material forms in which they happened to manifest themselves at any moment, and that the material form in which the soul (and noticeably this held good even of his own soul) happened at any moment to be embodied was of little or no real importance to that soul, which could continue to exist just as well without as with that body.

Another point which it is important to note is the egoism of the savage man as distinguished from the altruism of the civilized man; for it was perhaps the beginning of the idea of altruism, of duty to one's neighbor, that gave the start to civilization, and it was because the ancestors of the savage had never got hold of this fundamental principle of altruism that they were left behind.

The uncivilized man, complete egoist as he was, thought and acted only for his own personal interests. It is true that he was to a certain extent kind (as we might call it) to the people of his own small community and possibly still more kind to such of the community as seemed to him more immediately of his own kindred. But this kindness was little more than instinctive—little more than a way of attracting further service. It is also true that on the occasions, which must have been very rare till a late period in the Melanesian occupation of Fiji, when strangers —*i. e.*, persons of whom he had not even dreamed—came, so surprisingly, into his purview, he was sometimes civil or even hospitable to those strangers (it should not be forgotten that to him these were souls embodied by separable accident in material forms); but this would have been only on occasions on which he knew, or suspected, that these visitors were stronger than himself and able to injure or benefit him.

Another point of great significance in the character of this primitive man was that he had no conception of ownership of property. To him all that we should class as goods and chattels, his land, or even his own body, was his only so long as he could retain it. He might if he could and would take any such property from another entirely without impropriety; nor would he resist, or even wish to resist, the taking from himself of any such property by any one who could and would take it.

Again, the primitive man must have been far less sensitive to pain, and far less subject to fear, than the normal civilized man. I do not mean that the primitive Fijian was without the ordinary animal shrinking from physical pain, but that he can not have been nearly as sensitive even to physical pain as is the more sophisticated man; nor had he the same mental pain, the same anticipation and fear of pain, that the civilized man has.

Having thus dealt with some of the more important points in the character of the primitive Fijian, I propose next to consider how far these suffice to account for some of the more "savage" conditions under which these islanders when first seen were living.

Cannibalism claims the first mention, in that, though the practice has been recorded from many other parts of the world, it is commonly supposed to have been carried further in Fiji than elsewhere.

Here, however, it is at once necessary to point out that the outbreak of cannibalism in Fiji in the first half of the last century was not due to any innate and depraved taste on the part of the Fijians, and that the practise to the degree and after the fashion of which the story-books tell was not natural to the Fijian, whether of Melanesian or Polynesian stock.

It is probable, even perhaps certain, that all the Fiji islanders occasionally ate human flesh before the coming of white men to the islands; but it was only after the arrival of the new-comers that this practise, formerly only occasional and hardly more than ceremonial, developed into the abominable orgies of the first half of the last century. The first Europeans to set foot—about 1800—and to remain in the islands for any time were the so-called "beachcombers." At first at least, these renegades from civilization, to secure their own precarious position and safety, contrived to put themselves under the patronage of some one or other of the great native chiefs, who would be Polynesians, and assisted and egged on these chiefs in their then main occupation of fighting other great rival chiefs, also Polynesians, and raiding the less advanced Melanesians of the surrounding districts. The guns and ammunition which the beachcombers, in some cases at least, brought with them or managed to procure, and the superior craft which they had imbibed from civilization, greatly assisted them in this immoral purpose. Consequently a habit of cruelty, new to the Fijian, was implanted and developed, especially in the Polynesian chiefs. It became more and more a fashion for the greatest native warriors, thus egged on, to vie with each other in the number of their victims and in the reckless cruelty with which these were killed. Doubtless at first the victims were opponents killed in fight, sometimes great rival chiefs and sometimes mere *hoi polloi* who had been led out to fight, probably not very reluctantly, for their chiefs. Incidentally more and more people were killed; and the bodies of the slain were conveniently disposed of in the ovens. A taste for this food was thus developed in the chiefs—though this seems, for a time at least, to have been confined to the great chiefs, most of those of lower status, and all women, refusing to partake, at any rate till a later period. Before long, when the number of the killed ran short, the deficiency was made up by clubbing more and more even of their own people, till eventually the great native warrior took pride in the mere number of those he had killed and eaten.

It seems probable that even the coming of the missionaries, who first reached Fiji thirty or forty years after the earliest beachcombers, and at once began almost heroïc efforts to stop cannibalism, thereby to some extent temporarily even aggravated the evil. For the chiefs, in their characteristic temper of gasconade, killed and ate more and more unrestrainedly, in mockery of the missionaries and to show what fine fellows they thought themselves to be.

To return from this digression into a somewhat distasteful subject, cannibalism as practised by the Fijians before the com-

ing of white men was very different, and, from the Fijian point of view—if I may say so without fear of being misunderstood—not altogether indefensible. It must be remembered that there was, as it were, no killing in our sense of the word involved, merely a setting free from the non-essential body of the essential soul, which soul survived just as well without the body as with it.

Note that the soul must have been considered as in some way and for a time still associated with its late body if, as is commonly and perhaps rightly held, the slayer sometimes ate some part of the body of the slain in order to acquire some of the qualities of the slain.

Again, there can be little doubt that men were sometimes killed for sacrificial purposes, the material bodies of the victims being placed at some spot (perhaps the tomb) considered to be frequented by the disembodied spirit of some ancestor for whom it was desired to provide a spirit attendant. It may be noted that this sacrificial use of the body might be combined with an eating of the same body when once it had served its first purpose of attributing the spirit which had been in it to the service of the honored ancestor.

It has been laid to the charge of the Fijians (as to that of many other folk of savage and even of civilized culture) that they habitually killed strangers, especially such as had been washed or drifted to the islands by the sea—who, in early times at least, must have been almost the only strangers to arrive. The charge, like that of cannibalism, has been exaggerated, and the facts—as far as there were any—on which this charge was founded have been misunderstood.

Here, again, the attitude of the Fijian in this respect was hardly different from that of the lower animals under similar circumstances. The Fijian knew of no reason to be glad of the arrival of strangers, unless these could, in one way or another, be useful to him; and, as has already been explained, he knew of no reason why he should not make the best use possible of the stranger, of his body or his spirit, separately or together.

While, as must have been the case in earlier times, the new-comers were dark-skinned men like himself, the Fijian might without the slightest prick of conscience separate their bodies from their spirits, and dispose of the body or the spirit separately; or without effecting this separation, he might simply enslave the new-comers; or, again, if he suspected that the new-comers were too strong for him, he might yield himself to them as a slave.

And later, when Europeans began to arrive, sometimes as refugees from passing ships and sometimes as survivors from ships wrecked on the surrounding reefs, the bearing of the Fijian towards this new kind of stranger would have been on the same principles, only that in this case the new-comers, being of far less readily understood kind, would be regarded with more suspicion and also more respect. I believe that very seldom, if ever, was an inoffensive white man, wrecked sailor or other, killed, or treated with anything but kindliness and courtesy, even though the wrecked man's property might naturally be appropriated by the natives. It was only when white-skinned strangers became commoner, and frequently more offensive, and when familiarity had bred contempt, that they were killed, as nuisances, and, especially during the great outbreak of cannibalism, were eaten.

This point in the bearing of the islanders to white men might be further illustrated by a circumstance which, to my surprise, I have never found mentioned, *i. e.*, that

during the whole period while the missionaries were, with a rashness only justified by the circumstances, testifying against the natives of Fiji not one of these was killed, till at a much later period, when European influence was all but predominant in Fiji, Baker was killed and eaten under very special circumstances.

If it were possible to ascertain in each case the facts as to the reception by "savages" of the first white men they saw, it would almost certainly be found that the reception was apparently kindly, though this kindness may really have been due to fear and not to charity. It was, however, quite probable that at any moment the savage might find that his dread of the white man was unfounded, and in that case he might kill him (*i. e.*, separate his soul from his body) without hesitation, and after doing this his fear—he probably never had any affection for him—of the disembodied spirit of the white man might be as great, or even greater, than before.

Incidentally it may here be noted, as a further curious point, that a Fijian who thus quite remorselessly set free the soul of a stranger from his body would probably not often and not for long in his dreams be revisited by his victim, if a native; and perhaps not even if the victim were a white man, unless very remarkable. In other words, the victim survives only just so long as he is remembered. Captain Cook, we know, survived for very long, perhaps does so still; few, if any, of such beachcombers as were later killed in Fiji survived for any length of time; and the innumerable natives who were drifted or washed to one or other of the islands must for the most part have passed from memory soon after they were killed.

It has been suggested that the killing of strangers may have been for the purpose of preventing the introduction of disease; and it is certain that, perhaps even before the coming of white men, the islanders recognized that the advent of strangers was curiously often and most disastrously followed by the introduction of new diseases, either real diseases or at least some queer, unexplained influence which has so often made life not worth living for savages where white strangers have been.

The Fijians were hardly more notorious for cannibalism than for theft—and almost as undeservedly. There is hardly an account of the visit of a European ship in early times to any of the islands which does not mention that the islanders who came aboard took whatever they fancied, either quite openly or if furtively then without evincing anything like shame when discovered. This habit, which the explorers naturally called theft, was but the manifestation of a South Sea custom, due to the entire absence of any idea of personal property, which in Fiji is called keri-keri. To keri-keri was to take whatever you wanted and could take without the previous holder of the property preventing you. In old days no Fijian doubted his own absolute right to keri-keri, nor did he feel the very slightest shame in thus (as we should say) "depriving another of his property" or "stealing"; and even to this day the Fijian, provided that he is not really Europeanized, will keri-keri without shame. In short the idea of ownership and individual property never occurred to the natural Fijian. He took what he wanted, and was strong enough to take. But, on the other hand, he yielded up, practically without reluctance, whatever another stronger or cleverer than himself wanted and was able to take from him.

Of the many other charges of "savagery" made against Fijians, I can, in the time at my disposal, deal with but one

more, that as to their strange and gruesome habit of celebrating great occasions by killing their own folk. When a Fijian chief died, as we should say, or, as it seemed to the surviving natives when his soul left the body which it had for a time used, his widows, and other of his kindred and dependents, unwilling to be left behind, were strangled, often indeed helped to strangle themselves, that their bodies might be put into the graves, while their souls went gladly with that of the chief whom they had been accustomed to follow.

Again, when a chief built a house, some of his dependents, whom the great man told off for the purpose, willingly stepped down into the holes which had been dug for the house-posts, and remained there while the earth was filled in on to them, and continued thereafter as permanent supporters of the house.

Again, there is a tradition, which at least was not incredible to the natives, that a great chief one day went a-fishing, and caught many fish. Two brothers of humbler rank who happened to have come down to the same waterside, also to fish, were less successful. The chief, in a characteristic freak of generosity, presented his best fish to the elder of the two brothers, who, strictly according to Fijian custom, accepted the gift, but felt bound to make an immediate return, but he had nothing to give. Thereupon the younger brother, at his own suggestion, was clubbed by the elder, and his body presented to the chief in token that his soul would thereafter serve that chief.

It is even said that when yams and other vegetables were brought in as food for the chiefs by the dependents who had grown them for that purpose, the food-bearers, if there was a scarcity of fish or other suitable accompaniment for the vegetable diet, were themselves clubbed and their bodies eaten. This particular atrocity probably happened only after the habit of cannibalism had, as already explained, been unnaturally intensified. But the story is noteworthy in that the food-bearers are not represented as in any way dreading or shirking the use to which their bodies were put.

In all these and similar cases it is to be noted that the victims (as we are naturally inclined to call them) were more or less indifferent, if indeed they were not eagerly consenting parties, to the use (cruel as it seems to us) made of their material bodies. Thus the widows were eager to be strangled, and often even helped to do the deed, in order that they—all that was essential of them, *i. e.*, their souls—should rejoin the deceased. Similarly those others who were killed on the occasion of the funeral were quite willing to give their bodies, which seemed of comparatively little importance, as "grass" to be added to the cut fern and other soft material on which the body of the deceased chief was couched in the grave; and quite willingly the men told off for that purpose stepped down into the holes in which the house-posts were grounded, that they, or rather their bodies, might thereafter hold up the house, while their souls enjoyed life much as before but without the encumbrance of the body. Others again contentedly grew *taro* for the chiefs to eat, and carried it in when ripe, thinking it of little importance that their mere bodies might be eaten with the *taro*.

In conclusion, having endeavored to realize for myself, and to show you a glimpse, of the enormous, hardly conceivable difference in habit of thought, and consequently in character, which separates the savage from the civilized man, I will offer a suggestion which seems to me possibly the most important outcome of my personal experience, now closed, as an anthropolog-

ical administrator in tropical places where Eastern and Western folk have met, and where the inevitable clash between the two has occurred.

In such places and circumstances the result has too often been that sooner or later the weaker folk—those whose ancestors have been age-long "savages"—have died out in the presence of those whose ancestors long ago turned from "savagery" to civilization. This dying out of the weaker folk has happened even when the stronger people have done their best to avoid this extirpation.

The real ultimate cause of "the decrease of natives" when in contact with civilized folk lies, perhaps, in the difference in hereditary mentality—in the incapacity of the "savage" to take on civilization quickly enough. However sedulously the missionary, the government official, and others who take a real interest in so doing, may teach civilized precepts to the essential savage, the subject of this sedulous case—however advanced a savage culture he may have attained—will, at least for many generations, remain a savage, *i. e.*, for just so long as he is under influence of the civilized teacher he may act on the utterly strange precepts taught him, but away from that influence he will act on his own hereditary instincts.

The manner in which the native dies out—even when well looked after—varies. He may be killed out by some disease, perhaps trifling but new to him, with which he does not know how to cope, and with which—if he can avoid so doing—he simply will not cope in the ways which the civilized man would teach him; or he may be killed out by the well-meant but injudicious enforcement on him of some system of unaccustomed labor; or, again, he may die out because deprived of his former occupations [*e. g.*, fighting and the gathering of just so much food as sufficed for him] and thus restricted to a merely vegetative existence; or in many other more or less similar forms his extermination may come about.

But all such effective causes are reducible to one, which is that he is not allowed to act on his own hereditary instincts, that he can not at all times have, and often would not use, judicious and disinterested guidance from civilized folk, and that consequently he, the "savage," can not and too often does not care to keep alive when in the presence of civilized folk.

Everard im Thurn

GEORGE MARCGRAVE, A POSTSCRIPT

In the *Popular Science Monthly* for September, 1912, I published a biographical sketch of "George Marcgrave, the First Student of American Natural History." A copy of this paper was sent to Dr. Alfredo de Carvalho, Pernambuco, Brazil, president of the Instituto Archeologico e Geographico of that city, and a profound student of the history of his country and especially of that period during which the Dutch occupied Pernambuco and the adjacent parts of Brazil. He wrote me of his study of Marcgrave, who did his natural history work at and around Pernambuco, or Recife as it is called by the Brazilians, and sent me a copy of his article—"Um Naturalista do Seculo XVII, Georg Markgraf, 1610–1644"—in *Revista do Instituto Archeologico e Geographico Pernambucano,* Vol. XIII., pp. 212–22, 1908. I greatly regret that this paper was not included in my bibliography of George Marcgrave.

In speaking of Marcgrave's death it was stated in my sketch that this occurred on the Gold Coast of Africa, by which term was meant all that pestilential region around the Gulf of Guinea. However, the Gold Coast proper is a section of the coast lying west of the Bight of Benin, and there is good reason to believe that Marcgrave died in Angola at or near San Paulo de Loanda, some distance south of the mouth of the Congo.

In my paper all the intimate and personal

data concerning Marcgrave's boyhood, his 11 years of preparation for his life work, and his 6½ years of exploration and study in Brazil, were taken directly from a sketch found in Manget's "Bibliotheca Scriptorum Medicorum" (1731), and from authors who had gotten their data from this article. At the time the paper above referred to was written I had not had an opportunity of examining Manget's huge folio, and as the three gentlemen who had looked it over for me found nothing to indicate who was the author of the sketch of Marcgrave therein contained, I was at first inclined to think Manget himself the writer. However, the sketch was written in the first person by a man who personally knew Marcgrave, Count Moritz, Piso, and all the other principals in the Dutch expedition to Brazil of 1637–38, and as Manget was not born until some years after Marcgrave's death, I had to content myself with referring to "the unknown writer in Manget."

During the Christmas holidays, 1912, while at work in the libraries at Washington, I went to the Surgeon General's Library and personally looked over the sketch of George Marcgrave contained on pages 262–264 of Manget's volume II., but found absolutely nothing to indicate who was the writer. However, on the adjoining pages were a number of short sketches of various Marggrafs (the German spelling of the name), all of which were worked over. Presently I came to Christian Marggraf (1612–1687) who, it was stated, published "Prodromus Medicinæ Practicæ" in 1674, "Materia Medica Contracta" in 1674, and in 1715 "Opera Medica Duobus Libris Comprehensa." Following the last title came this highly interesting statement:

> In hac libro anteponitur vita fratris ejus natu majoris Georgii Marcgravii quam infra subjectam videas. (In this book there is placed at the front the life of his older brother, George Marcgrave, which you may see appended below.)

Search was immediately made through the catalog of the Surgeon General's Library, and the Prodromus and the Materia Medica were both found, but the Opera Medica was lacking. This search was extended to a number of the large libraries throughout the east, but none of them contained the Opera. However, Mr. Charles Perry Fisher, Librarian of the College of Physicians, Philadelphia, kindly informed me that the "Opera Medica" simply consists of the "Prodromus" and the "Materia Medica" united and republished under the new title "Opera Medica" in 1715. Since the book could not be found in America, an effort was made to locate it in Europe, and a copy in perfect condition was reported in the Library of the Faculty of Medicine in Paris. This book was wanted that it might be ascertained whether Manget had published everything that Christian Marggraf had written about his brother George. About this time a letter was received from Dr. Perlbach of the Royal Library of Berlin, which effectually cleared up the whole matter. (I had previously written Dr. Perlbach, who had supplied me with much valuable data for the original paper on George Marcgrave.)

He stated that the Royal Library of Berlin does not contain "Christian Marggravius: Opera Medica Duobus Libris Comprehensa, Amstelodami apud Franciscum van der Plaats, 1715, 4°"; but that it does have his "Prodromus Medicinæ Practicæ, Lugduni Batavorum, ex officium Arnoldi Doude, 1673, and 1674, 4°" (it seems probable that the printing began late in 1673 and ran over into the next year); also it has the same "Editio 2 auctior Lugduni Batavorum apud Cornelium Bontestyn, 1685, 4°." Further the Royal Library also has "Materia Medica Contracta, Lugduni Batavorum apud Arnoldum Doude 1674, 4°," and the same "Editio 2 aucta Amstelodami apud Henricum Wetstenium 1682, 4°."

Touching the matter particularly in hand, Dr. Perlbach then concluded:

> In the second edition of the Prodromus (1685) there are found (following the preface [dated at] Lugduni Batavorum, Calendis Februarii, 1685), four unpaged leaves containing the life of George Marcgrave, which Manget, Bibliotheca Scriptorum Medicorum II., pp. 262–64, prints word for word with the edition of the author. I have compared the two texts, and with the exception of some

typographical errors and a line omitted by Manget they agree word for word.

The line referred to merely tells us that Count Moritz had added Marcgrave to his expedition as his friend and associate.

There is internal evidence in the sketch in Manget which now clearly corroborates the above, for in the last paragraph the writer refers to "this man of most delightful memory standing to me as an older brother." Now also is made clear the dislike, amounting almost to hatred, of this writer for Piso, who is charged with doing everything in his power to enhance his reputation at the expense of Marcgrave's, calling Marcgrave "my domestic," minimizing his importance as a member of the expedition, his work as a collector and observer of natural objects, and his standing as a scientific man.

Exceedingly unfortunate is it that Christian was never able to carry out his purpose expressed in these words:

His [George's] Brazilian itinerary, if God will so permit, I shall publish, because it contains an exact description of his voyage to Brazil, together with notes on winds, rains and calms. It will not lack accounts of fishing and hunting with the barbarians, and geographical descriptions and notices of places.

By this is probably meant a publication of George Marcgrave's journals, of which notice is made in the body of Christian's sketch and concerning which all the known facts are given on page 254 of my paper (1912). This, however, he unfortunately never lived to do, for the sketch was dated February, 1685, and he died two years later in his seventy-fifth year.

Of Christian Marcgrave I am able to give only this small but interesting bit of information. In my copy of the "Historia Naturalis Brasiliæ" by William Piso and George Marcgrave (Leyden and Amsterdam, 1648), which bears as a book-plate a coat of arms and underneath the word LAETVAERENNYDT and the name of the maker of the plate, there are on the fly leaf opposite the engraved title page two short handwritten sketches in French, one of Piso, the other of Marcgrave. At the close of that on Marcgrave is found this interesting statement:

His brother Christian, born at Liebstadt in Meissen, was made a doctor by the Faculty of Medicine at Franeker in 1659, and occupied the chair of pathology at Leyden until death overtook him in 1687. We learn that his two books printed separately were afterwards united and published under the title "Opera Medica Duobus Libris Comprehensa," Amsterdam, 1715, in quarto.

Lower on the same page is found, in the same handwriting as the above, this sentence:

Cet ouvrage a été vendu 32 francs a la vente des livres de M^r l'heritier.

Franeker is a town in Friesland whose university, founded in 1585, was abolished by Napoleon in 1811. "Cet ouvrage" of course refers to the "Historia Naturalis Brasiliæ." There is nothing whatever to indicate who this "monsieur the heir" was, whether heir of the man of the book plate or of an earlier or later owner.

One more point may be added. In a recent catalogue of Dulau and Co., of London, there appeared in an advertisement of Piso and Marcgrave's work the statement that the figures were engraved by de Bray. No information has been obtainable as to who de Bray was or why he was chosen to engrave these figures. That the work was very poorly done an inspection of the "Historia Naturalis Brasiliæ" shows.

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THE EFFECTS OF THE KATMAI ERUPTION ON MARINE VEGETATION

UNDER an appointment as scientist in kelp investigation in the United States Bureau of Soils[1] the writer visited the coast of southwestern Alaska in the summer of 1913. During June and July the coast of much of the region affected by the eruption of Katmai volcano in June, 1912, was visited. The events attending this eruption have been described

[1] This expedition was a part of the general investigation of the fertilizer resources of the United States carried on under the direction of Dr. Frank K. Cameron, of the U. S. Bureau of Soils.

by Perry;[2] the effects of the eruption as seen in June and July, 1912, by Martin;[3] the composition of the ash that fell at Kodiak by Fry;[4] and the effects of the eruption on land vegetation by Griggs.[5]

The eruption was a violent one and proved fatal to a considerable amount of life both plant and animal. It also modified, at least temporarily, the conditions of plant life on the eastern portion of the Alaskan Peninsula and on Kodiak, Afognak and Shuyak Islands and the neighboring smaller islands.

Katmai volcano is situated toward the eastern end of the Alaskan Peninsula. It is about 24 km. north of the nearest point of Shelikof Strait and about 104 km. southwest of Cape Douglas. The wind was westerly at the time of the eruption so that the regions principally affected were those situated immediately to the eastward.

Of the effects of this eruption on marine vegetation as seen in the two months following its occurrence, Martin says:

> Marine life was affected to a larger degree than would perhaps be expected. . . . Kelp is apparently dead as far as the eastern end of Afognak Island.

Such injury to marine vegetation as was still apparent when the writer visited this region, over a year after the eruption, had evidently resulted from one or more of the following causes: (1) the grinding effect of the floating pumice, (2) actual burial of plants by the deposit of ash, (3) the burial by the ash of rocks which had furnished anchorage for marine algæ, (4) the effect of poisonous gases on plants growing in the littoral zone or whose distal portions are kept at the surface of the water by floats.

Of the masses of floating pumice, as seen in August, 1912, Martin says:

> The pumice is being washed into the sea by the combined action of streams, waves and tides. There it forms great floating fields which migrate with the winds and tides and greatly impede the navigation of small craft such as ours. An immense field of pumice . . . visited our anchorage at Takli Island. . . . This visitor came and went under the influence of tidal currents and winds, and constituted a menace which led us to seek a more sheltered nook for our boat. Even this was invaded by the floating rock, which jammed tight around and carried our boat with it when it moved, in spite two anchors and two pieces of pig iron down, and forced us to make fast to a projecting cliff. The floating pumice was twelve inches thick alongside the boat and possibly was much thicker in the center of a large field. Fishermen reported a pumice field dense enough to support a man in Shelikof Strait.

In July, 1913, the schooner from which we were conducting the kelp investigation passed through fields of floating pumice more than 241 km. west of Mount Katmai. Some of these fields were as much as 213 m. long and 15 m. wide. In several places the fields were so dense that we scooped up quantities of pumice with a dip net as our schooner passed through them. Drifts of pumice 20 cm. or more in depth were found in August over considerable areas on the beach of a lagoon opening from Popof Strait in the Shumagin Islands. In the region principally affected by the volcanic eruption we found considerable quantities of pumice drifted up on the beaches but did not encounter any floating fields of it. Reports from residents agree, however, that there were extensive fields in Shelikof Strait, Kupreanof Strait and other waters of the region in 1912.

Undoubtedly the grinding effect of the continued movement by tides and waves of the rough pieces of pumice composing these floating fields must have caused considerable injury to beds of *Nereocystis luetkeana* and *Alaria fistulosa,* both of which species are anchored to the bottom and are provided with floats that keep the distal portion of the plant at the surface of the water.

[2] Perry, Captain K. W. (U. S. R. C. S.), extract from report, *The National Geographic Magazine,* 23, 824–832, 1912.

[3] Martin, George C., "The Recent Eruption of Katmai Volcano in Alaska," *The National Geographic Magazine,* 24: 131–181, 1913.

[4] Fry, William H., "The Mineral Content of Volcanic Ashes from Kodiak," Science, N. S., 36: 682, 1912.

[5] Griggs, Robert F., "The Effects of the Katmai Eruption on Land Vegetation."

There are some reasons for believing that the grinding effects of these huge masses of rough pumice would be more destructive to *Nereocystis* than to *Alaria*. The growing region of *Nereocystis* is at the bulb, which floats on the water. It is from this growing region that the stipe elongates at its distal portion and the fronds elongate at their base. Serious bruising of this would undoubtedly kill the plant. *Alaria*, on the other hand, has its growing region near the base and the distal end of the frond is usually more or less frayed and ragged as a result of the action of tides and waves. This kelp has continuous regeneration of the frond from this growing region which is so far below the surface of the water as to be safe from any direct injury by floating materials of any kind, and it is possible that individuals might be still living although portions at the surface of the water looked worn and dead. We found considerable beds of *Alaria* at many places on the south shore of Shelikof Strait and at a few places on the north shore. A bed was found at Cape Atushagvik only about 38 km. from the volcano.

At the time of our visit *Alaria* was much more abundant in the region affected than *Nereocystis*. There were many beds of pure *Alaria*, but there were very few of pure *Nereocystis*. There were only a few cases in which the two species were mixed throughout the bed. These facts can not, however, be taken as indicating that the injury was greater to *Nereocystis* than to *Alaria*, for they were true outside of the region affected by the volcano as well as in it.

A good deal of injury to *Fucus* and other plants growing in the littoral zone may also have been done by the grinding effect of this pumice. It is of course well known that *Fucus* has restorative regeneration of its fronds,[6] but we could not detect that this was any more common in the regions affected by this eruption than it was in other portions of Alaska or of Puget Sound. On several exposed rocks at Russian Anchorage (35 km. from the volcano) we found that practically all of the growing *Fucus* was young, much of it not yet producing spores. Among these young plants were found the harder basal portions of old fronds.

It seems quite possible that the softer portions of these plants had been killed by the grinding of the pumice. On other rocks close by, the growth of *Fucus* was abundant, and the plants were vigorous and in fruit. In addition to *Fucus* twelve genera of Algæ were found in the littoral zone at this point. These were all fairly abundant and were in good condition except that many of the red algæ were considerably faded. This, however, the writer has found to be the case locally at several points in Alaska and in Puget Sound. The genera that we found in the littoral and upper sublittoral zones at Russian Anchorage are *Ulva, Laminaria, Alaria, Agarum, Halosaccion, Callophylis, Hildenbrantia, Corallina, Porphyra, Gloiopeltis.*

The maximum fall of ash resulting from this eruption approximated 139 cm. Some portions of the northern shore of Shelikof Strait received as much as 76 cm. The southern shore of this strait received 51 cm. in some portions, and Kupreanof Strait received from the latter amount down to 18 cm. Wherever this deposit was heavy the result was that the Algæ in the flatter portions of the littoral zone were completely buried. In Kupreanof Strait and in the south shore of Shelikof Strait we saw but little effect of the ash on littoral seaweeds. At Russian Anchorage near Cape Atushagvik on the northern shore the results of the ash were more evident. On a flat beach at that place the covering of ash had resisted the action of waves and tides and occasional bunches of *Fucus* on rocks large enough to reach the surface of this layer of ash was all that was left of the littoral vegetation. Not only had the 1912 crop of *Fucus* been buried here but the 1913 crop had been seriously interfered with by the covering of the stones that would have served for anchorage.

It seems probable that in some places sufficient material has been deposited on the bottom

[6] See Setchell, W. A., "Regeneration Among Kelps," Univ. of Calif. Pub. Botany, 2: 139–168, 1905, and the literature there cited.

to cover the rocks and stones and thus destroy all opportunity for anchorage for kelps. When we lifted the anchor (from a depth of 8 fathoms) at Russian Anchorage it was well covered with volcanic ash.

Fry states that glass predominates in the three samples of ash from Kodiak examined by him. He found also feldspars, muscovite, apatite, hornblende, biotite and "undeterminable particles of what appear to be a ferromagnesium mineral." These three samples represented the three falls of ash that occurred in the few days following the first eruption on June 6, 1912. He says that there "glasses would probably react with the soil water" and that "no substances deleterious to plant growth were revealed by the examination."

The injury to marine plants by gas was probably less than from the causes cited above. The presence of sulphurous fumes in the atmosphere was not confined to the time of the eruption but was noted as late as August 16 at a distance of 350 miles north of the volcano. On August 15 at the mouth of Katmai River Martin notes that during a rain "the drops of water striking the eyes produced sharp pain, and brass and silver were tarnished by the drops." On July 27 sulphurous fumes were evident on board the U. S. revenue cutter *Manning* 193 km. east of the volcano. Vegetation on the volcano itself was annihilated. Martin says that the death line "came practically down to the sea 24 km. from the crater" and suggests a hot blast as the cause of the death of vegetation. It seems improbable that a hot blast or poisonous gases caused any great damage to marine plants.

Human interest in the effect of this volcanic eruption on marine vegetation centers chiefly around the two large kelps—*Nereocystis luetkeana* and *Alaria fistulosa.* These kelps, as Martin has noted, are an important aid to navigation. They are a warning to navigators of shallow water, and in a region where there are practically no aids to navigation except such as nature has provided, these kelps are really important. These two kelps (principally *Alaria*) are universally used by the natives of Kodiak Island and the neighboring islands as fertilizer for their potato gardens, and are in this way of considerable economic importance. The 1912 crop of beach grass and other grasses which are ordinarily used as pasturage and hay for the cows kept in this region was practically all destroyed by the volcano. During the winter that followed the few cattle that were still kept in the region are reported to have lived largely on what kelp was to be had on the beach. To these reasons for local interest in these kelps must also be added the fact that they are now to be considered as a possible source of potash fertilizer.[7]

Information obtained by personal interviews with residents of the region indicates that there was large injury to the 1912 crop of kelp, and that even the 1913 crop was far short of that of the years preceding 1912. It seems that the beds became much thicker later in the season than they were at the time of our visit. A reliable informant reports that in December, 1913, the kelp was practically continuous from Afognak village to Little Afognak village. There were only scattering beds at that place when we visited it in June and July.

The fact that there was, previous to 1913, practically no information as to the relative amount of *Nereocystis* and *Alaria* in the region makes it impossible to say which of these suffered more damage as a result of the eruption. It seems probable that both of these species mature from spores in a single year,[8] so that where there were enough individuals left for "seed" the crop would soon become

[7] Cameron, F. K., *et al.*, Sen. Doc. 190, Sixty-second Cong., second session, 1911; "Possible Sources of Potash in the United States," Yearbook U. S. Dept. Agr., 523–536, 1912; "Kelp and Other Sources of Potash," *Jour. Frank. Inst.*, 176: 347–383, 1913.

[8] On the duration of *Nereocystis luetkeana*, see Frye, T. C., "*Nereocystis luetkeana*," *Bot. Gaz.*, 42: 143, 1906; Setchell, W. A., "*Nereocystis* and *Pelagophycus*," *Bot. Gaz.*, 45: 125, 1908; Rigg, G. B., "Ecological and Economic Notes on Puget Sound Kelps," Sen. Doc. 190, Sixty-second Cong., second session, 179–193, 1911; "Notes on the Ecology and Economic Importance of *Nereocystis luetkeana*," *Plant World*, 15: 83–92, 1912.

normal again unless the environment had been essentially changed.

In the main, the effects of this eruption on marine vegetation were temporary. The burial of rock that had served for anchorage will no doubt interfere permanently in some places with algæ in the littoral zone. It is possible that this same cause may also lessen the production of the two large kelps, *Nereocystis luetkeana* and *Alaria fistulosa*, but the evidence now at hand indicates that these kelps are well on their way toward recovery.

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EFFECT OF LIGHTNING ON A REINFORCED CONCRETE AND STEEL DOME

Owing to the increased use of reinforced concrete for buildings I have thought that an account of the effects of lightning on a metal dome surmounting walls of this construction may be of some general interest and of particular interest to astronomers.

On the afternoon of January 2 last occurred the heaviest thunderstorm in the immediate vicinity of the observatory since I came to Córdoba. The conditions were well marked—the weather had been very hot and sultry for several days, the barometer had been falling steadily and was low. The center of the storm, judging from the clouds and their motions, was not over a mile south by southeast of the observatory. In an area between one and two miles in diameter the clouds were very dark and low and masses of dark scud moved about underneath them.

In nearly all the storms which I had seen here previously the discharges were nearly all between clouds. (Perhaps because most of them occur at night?) In this storm nearly all of the discharges were between the clouds and earth.

Very heavy single flashes of lightning began about 2^h 20^m P.M. Córdoba time—apparently under the blackest part of the clouds and not over a half mile away. All of these which I saw were discharges between the clouds and earth, as also with only one exception, were all which discharged within a half mile of the observatory.

The direction of motion of this storm, as is usually the case, was from south to north. After some half dozen discharges close to the south there was a heavy one to the northwest about three hundred meters away—then another to the northeast about the same distance.

On account of this being a heavy storm and apparently passing directly over us, I was interested to see what the effect would be on our two new reinforced concrete walls and steel domes sheathed with galvanized iron, and was outside among the central group of buildings and not over 100 feet from the dome in question, one of them in full sight.

A minute or two after the flash to the northeast, mentioned above, there was a general illumination close by, followed almost instantly by the ripping sound of a very close stroke. The interval between the flash and the sound was certainly not over $\frac{1}{10}$ second. To me the sound appeared to be made up of three or four separate discharges blended into one—not consecutive.

I was standing within a few feet of the machine shops in easy hearing of the noise of the machinery. This noise stopped instantly after the flash. The main fuse on the light circuit had been blown twice before the flash, probably by induced currents. It was also blown again at the time of the flash.

Mr. Mulvey was in the underground optical shop at the time and thought there had been an explosion in the shop. He saw a flash and immediately afterward the lights went out. It was later ascertained that one lamp had burned out, which probably caused the flash which he saw in the shop. No other damage was done there. The circuits and machines were carefully examined but aside from the fuses being blown at the pump motor, on the 220-volt alternating current no sign of a spark was found.

The power and light currents were cut off until about 6 P.M., when it was found that fuses had been blown on our lines (which were special ones) just outside the step-down-station, some 400 meters away. No other effects of the storm were noticed in or near this station.

The dome which had just been completed was barely out of sight from where I stood and no one at the observatory seems to have seen the actual flash. A peon however in the grounds of the Meteorological office about 100 meters away had a full view of both domes and buildings, was facing them and saw the flash just over and about the new dome. This accords well with the direction and distance from my point of observation.

After hearing of this observation I made a careful examination of the dome and in particular the connection of the copper cable with the track upon which the dome revolves, which forms the connection between the metal dome and one of the vertical I beams imbedded in the concrete for grounding the circuit. The lightning-rod proper extends about a meter above the highest part of the dome and terminates in a brush of heavy wire. No signs whatever of any discharge have been found at any point about the dome.

Close to the dome stands the wooden derrick which was used in its construction, the top of which is about two feet higher above the ground than the lightning-rod. Three wire cable guys lead off to trees, two of which actually touch the ground—but scarcely so—and a fourth to a brick building. The cable used for lifting did not touch the ground. Careful examination of all of these points failed also to disclose the slightest sign of a spark.

The three wires of the alternating power circuit pass close to both dome and derrick.

About 70 or 80 meters east and west are, respectively, three lightning rods on the director's residence, and one on the assistants' house. To the south some 100 and 150 meters, respectively, are the metallic tower for the windmill and water tank, about 50 feet high and the first astronomer's residence with two lightning points.

I have been particular in referring to these various conductors, for it seems probable that so many must have been instrumental in reducing the difference of potential somewhat.

The bolt which struck the dome was undoubtedly not a light one for it frightened badly a number of persons in the residences near by and was described by several as a very bright flash. I do not think, however, that it was an especially heavy one, possibly not so heavy as most of the others which struck in the vicinity.

The peon who saw it from the neighboring quinta, was seated at the time under a shed and watching the dome. He says the flash appeared to descend as a single ray, striking the lightning rod and then the whole surface of the metallic dome appeared to be covered with sparks or flashes.

At the time the bolt struck there was a peon inside the closed dome, cleaning the running-gear. When questioned he said he had felt nothing nor had he noticed anything unusual beyond the heavy noise.

It seems certain, therefore, that the dome was actually the principal point of discharge for a fairly heavy flash of lightning. (It is uncertain how much of the discharge was taken by the derrick, but it would appear to have been relatively small.) That the induced currents in the light and power lines were sufficiently heavy to blow the fuses in both.

This experience seems to be a fairly severe test for such a construction—a metallic dome surmounting concrete walls which are heavily reinforced with iron—the metal in the walls having a good ground connection and being connected also with the dome.

From the effects in this case one concludes that after the resistance of the air was broken down, the dome and metal in the walls were ample to carry off the discharge without the slightest apparent damage to either the structure or the man who was inside at the time.

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SCIENTIFIC NOTES AND NEWS

An international committee has been formed to establish a foundation in memory of Henry Poincaré. A medal will be struck in his honor, and a fund will be established under the Paris Academy of Sciences to en-

courage or reward young scholars engaged in work in the directions in which Poincaré led, namely, mathematical analysis, celestial mechanics, mathematical physics and scientific philosophy. The members of the executive committee are Messrs. Appell, Lamy and Daboux, and there is a large and distinguished international committee. Copies of the medal will be sent to subscribers, who should send their subscriptions to M. Ernest Lebon, Rue des Écoles 4, Paris.

Dr. Erwin Baur, of Berlin, who was to have been the Carl Schurz memorial professor at the University of Wisconsin during the first semester this year, was stopped by the English on his way to Java and was held for a time at Port Said. He managed, however, to get away and, after many difficulties, to return to Berlin, where he is now stationed in the Marine Office. It will be impossible for him to come to America before the end of the war.

Dr. Woldemar Voigt, professor of mathematical physics at Göttingen, exchange professor from Germany, will probably not be able to give his courses at Harvard University during the second half-year, although it is still hoped that the war may not interfere with the arrangements between Harvard and the French and German universities.

Professor Pierre Boutroux, of the department of mathematics of Princeton University, has remained in France in the service of the French government.

The British Medical Journal states that Dr. Noyons, professor of physiology, at Louvain, has recently distinguished himself by his heroic conduct in remaining with his wife among the ruins of Louvain ministering to the wounded—Germans as well as Belgians. When the population of the city was informed that every inhabitant of the town must leave immediately, in order that the town might be razed to the ground by artillery, Dr. Noyons and his wife decided to remain in order to protect the 150 wounded who could not be removed in time.

Dr. Wilhelm Foerster, professor of astronomy at Berlin, who holds a doctor's degree from Oxford, takes objection to the movement to renounce English degrees in a letter to the *Berliner Tageblatt*, quoted in the London *Times*, on the ground that it is unwise to proclaim a divorce from the "learned world" of England because of England's "wicked policy."

Dr. Eugen de Cholnoky, professor of geography at the University of Kolozsvár, Hungary, has been elected president of the Royal Hungarian Geographical Society, Budapest, for the term expiring in 1917. The former president, Professor Louis de Lóczy, director of the Royal Hungarian Geological Survey and the well-known China explorer, became honorary president.

Dr. Otto Finsch, the well-known ethnographer and geographer of Brunswick, celebrated on August 8 his seventy-fifth birthday.

Dr. Maynard M. Metcalf, professor of zoology at Oberlin College, has retired from the faculty and is devoting his entire time to research in a private laboratory recently erected on his own grounds.

Sir Ernest Shackleton and the members of his Transantarctic Expedition left London on September 18 for the South Polar regions. The explorers departed in two sections, the portion for the Ross Sea or New Zealand side of the Antarctic leaving in the morning *via* Tilbury for Tasmania, and the Weddell Sea section, including Sir Ernest Shackleton, leaving for South America later in the day. The *Endurance*, the ship of the Weddell Sea party, left Plymouth on August 8. The Ross Sea ship *Aurora* is to leave some Australian port about the beginning of December.

Dr. W. S. Bruce, of the Scottish Spitzbergen Expedition, accompanied by Mr. J. V. Burn-Murdock, Mr. R. M. Craig and Mr. John H. Keoppern, arrived in the Tyne from Bergen on September 18. The party left Newcastle on July 9 for scientific exploration in Spitzbergen.

Professor R. H. Whitebeck, of the department of geology and geography of the University of Wisconsin, has been granted a leave of absence for the present semester and will spend the time in research work with the Carnegie Institution at Washington.

Dr. Lemuel Bolton Bangs, a prominent surgeon of New York City, professor in the University and Bellevue Hospital School, died, on October 4, at the age of seventy-two years.

The death in announced at the age of eighty-three years of Mr. Edward Riley, who was early associated with the production of Bessemer steel.

Sir Henry G. Howse, at one time senior surgeon to Guy's Hospital, and president of the Royal College of Surgeons, England, has died at the age of seventy-three years.

Dr. Eugen von Böhm-Bawerk, professor of economics in the University of Vienna, member of the Austrian upper house and formerly minister of finance, president of the Vienna Academy of Sciences, died on August 27, at the age of sixty-three years.

Dr. H. J. Johnston-Lavis, professor of vulcanology in the University of Naples, was killed in a motor accident last month.

The British Medical Journal calls attention to the fact that Louvain was in old times, as it is still, chiefly celebrated as a school of theology, but for anatomists it is associated with the great name of Andreas Vesalius. The reformer of anatomy was a student in the *pædagogium castri* and also in the *Collegium Buslidianum*, where he gained that knowledge of the ancient tongues which was to prove of such service to him in the scientific controversies of his later life. It was when he was at Louvain that Vesalius secured a human skeleton by climbing the gallows outside the town. He had to convey the bones home secretly, reentering the town by a different gate from that by which he had gone out, and articulating his stolen treasures in his rooms. He was afterwards spared the work of "resurrection" by the liberality of the burgomaster, who placed abundance of material for dissection and demonstration at his disposal. In 1536 or 1537 he dissected and lectured publicly. He seems, however, not to have been altogether comfortable in the theological atmosphere at Louvain, and some remarks which he made on the seat of the soul excited the suspicions of the heresy hunters.

In 1902 Dr. and Mrs. Christian A. Herter, of New York, gave to the Johns Hopkins University the sum of $25,000 "for the formation of a memorial lectureship designed to promote a more intimate knowledge of the researches of foreign investigators in the realm of medical science." According to the terms of the gift, some eminent worker in physiology or pathology is to be asked each year to deliver lectures at the Johns Hopkins University upon a subject with which he has been identified. The selection of the lecturer is to be left to a committee representing the departments of pathology, physiological chemistry and clinical medicine, and if "in the judgment of the committee it should ultimately appear desirable to open the proposed lectureship to leaders in medical research in this country there should be no bar to so doing." The committee named for this purpose consists of Drs. Welch, Abel and Barker. The eighth course of lectures on the Herter foundation will be given by Thomas Lewis, M.D., lecturer on diseases of the heart, University College Hospital Medical School, London. The lectures are being given in the auditorium of the Physiological building, at 4:30 P.M., as follows:

I. *October 6.*—"Observations Exemplifying Electrocardiography."

II. *October 8.*—"The Relation of Auricular Systole to Heart Sounds and Murmurs."

III. *October 9.*—"Observations upon Dyspnœa, with Especial Reference to Acidosis."

An examination for a food chemist at a salary of $100 to $150 a month under the civil service of the State of Illinois will be held on November 7. Further information can be obtained from the Illinois State Civil Service Commission, Springfield, Illinois.

The Fuertes Observatory, of Cornell University, is to be torn down and rebuilt on a site north of Fall Creek Gorge, northeast of the campus. It will stand on a slight knoll at the southwest corner of the Hasbrouck farm, near the upper end of Beebe Lake.

The Royal Zoological Society of New South Wales has begun the publication of *The Australian Zoologist*, the first number of which contains the annual report of the council of the society and of the zoological gardens that it conducts. The publication also contains a number of articles concerned with zoology in Australia.

Last year the imports of mineral products, both crude and manufactured, exceeded $270,000,000. Of this total probably $200,000,000 represents raw materials and crude metals, the value of these imports being about 8 per cent. of that of the domestic output. In this list of imports the larger items named in the order of value are unmanufactured copper, precious stones, nitrate of soda, copper ore and matte, nickel, tin, iron ore, pig iron and steel, petroleum products, manganese ores and alloys, platinum, aluminum, pyrite, graphite, stone, potash and magnesite. This country has an abundant supply of most of these mineral products that are now imported in large amounts, and as to them it can be independent of foreign countries. The only essential minerals of the first rank of which the United States has no known supply at all commensurate with its needs are nitrates, potash salts, tin, nickel and platinum, the list thus comprising two essential mineral fertilizers and three very useful metals. There was a decrease in the output of magnesite in the United States from 10,512 short tons, valued at $84,096, in 1912, to 9,632 tons, valued at $77,056, in 1913. The only production in this country was in California, as heretofore. With the cutting off of the foreign supplies, due to the European war, however, the demand for the domestic product ought to increase greatly, especially in view of the new and shorter water route by way of the Panama Canal to the eastern United States. It is to be hoped that the sudden stimulus thus given to the domestic mining industry will build up a trade that will withstand the competition that must undoubtedly ensue when normal trade conditions are again established. The demand for the domestic product is restricted to the Pacific coast and Rocky Mountain region, as it has been impossible at the present railroad freight rates to ship to the points of largest consumption in the East. In answer to inquiries addressed to them by the Geological Survey, many owners of idle magnesite properties in the far West express the belief that with the opening of the Panama Canal they would be able to ship magnesite by sea to the east at a profit. Magnesite is used principally in the manufacture of refractory substances, such as brick, furnace hearths, crucibles, etc.; as magnesium sulphite, for digesting and whitening wood-pulp paper; in the crude form for making carbon dioxide; calcined and ground for the manufacture of oxychloride cement; and for miscellaneous applications in crude form or as refined magnesium salts. In the toilet and bath rooms of the rest rooms of the Panama-Pacific Exposition at San Francisco, magnesite flooring has been laid, about 5,000 square feet having been put down in each of the main buildings. The domestic product is used in this work. A copy of the advance chapter from "Mineral Resources for 1913" on the production of magnesite in 1913, just issued by the U. S. Geological Survey, may be obtained upon application to the director.

The United States Bureau of Mines, in cooperation with the United States Geological Survey, has undertaken additional and more comprehensive investigations pertaining to the problem of mine caves and surface support. The immediate work of the mining engineers and geologists will comprise detailed studies of the extensive open-cut and underground mining operations in southwestern New Mexico. The field investigations will be conducted with special reference to earth pressures and surface subsidence in relation to the geological formation and mining conditions, and the equipment and efficiency of the

large mechanical installations in operation there. The Bureau of Mines, it will be remembered, has already done a large amount of work in the problem of mine caves. Director Holmes and several mining engineers served in an advisory capacity on the board of the Scranton Mine-Cave Commission. Mining engineers of the bureau gave the subject special attention in their studies of European mining methods and conditions. A mining engineer of the bureau served as a member and represented the cooperation of the bureau on the Pennsylvania State Anthracite Mine-Cave Commission, and in the investigations conducted in connection therewith extensive tests of mine-roof supporting materials were made at the Pittsburgh Experimental Station. The mining engineers and geologists of the bureau cooperated with the Scranton City Council, the Bureau of Mine Inspection and Surface Support, consulting engineers, and the Surface Protective Association in studies and reports for the development of practicable solutions of the serious mine caves occurring during recent years. Charles Enzian, mining engineer of the anthracite region, under the direction of Chief Mining Engineer George S. Rice, will represent the Bureau of Mines in this cooperative investigation.

UNIVERSITY AND EDUCATIONAL NEWS

THE new buildings and grounds of Richmond College were occupied at the beginning of the academic year. After eighty-two years on the site in the heart of the city of Richmond, the college opens the session of 1914–15 in new buildings on a campus of 150 acres in the western suburbs of the city. The opening of Westhampton College, the new coordinate college for women, occurred on the same day. The new grounds and buildings of Richmond College for men have a valuation of $850,000 and those of Westhampton College for women of $400,000. The buildings are of collegiate Gothic architecture and were designed by Messrs. Cram and Ferguson of Boston and New York.

CAPTAIN THOMAS J. SMITH, of Champaign, Ill., has given land, valued at more than two hundred thousand dollars, to the University of Illinois, to make possible the erection of a building to house the department of music.

AT the opening of the Boston University School of Medicine, Dean Sutherland announced that a gift of $100,000 had been received for the establishment of a maternity hospital.

WE learn from the London *Times* that the Belgian minister in London has received a letter from the council of the senate of the University of Cambridge offering to professors, teachers and students of the University of Louvain such facilities in the way of access to libraries, laboratories and lectures, together with the use of lecture-rooms, as may secure the continuity of the work of that university during the present crisis. While the University of Cambridge is not in a position in its corporate capacity to offer direct financial assistance for the support of members of the University of Louvain, efforts are being made in Cambridge to provide such help privately. Mgr. Barnes, Roman Catholic chaplain of the University of Cambridge, has explained that the university had invited the University of Louvain to migrate to Cambridge, and there to continue its own separate studies, granting its own degrees and generally continuing its activities as at its own foundation, Cambridge supplying the facilities necessary for the technical carrying out of the work. Hospitality in the way of living accommodation and so forth would probably be offered by the individual colleges and by private residents. Through the American Legation at The Hague the professors of the University of Oxford have offered a home for the winter to the young children of the professors of the ruined University of Louvain. Dr. van Dyke has sent the message by two messengers over two different routes, hoping that one or the other may carry it through. The academic staff of University of London, University College, are prepared to offer hospitality to about 70 members of French and Belgian universities, whether professors, teachers, or students, men or women, who may find it necessary to

take refuge in England. Special arrangements will be made as far as possible to meet the needs of French and Belgian students who desire to continue their studies in London.

Professor Frank H. Constant, formerly of the University of Minnesota, becomes head of the department of civil engineering at Princeton University, succeeding Professor Charles McMillan, who has retired and been elected professor emeritus.

John E. Bucher, associate professor of chemistry at Brown University, has been promoted to be head of the chemistry department to fill the vacancy caused by the retirement of Professor John H. Appleton. Dr. Harold Bigelow, of Mount Alliston University, is added to the faculty as assistant professor of chemistry.

Dr. Charles Alton Ellis, formerly of the University of Michigan, and recently engaged as a practising engineer, has been appointed assistant professor of civil engineering in the University of Illinois.

Dr. E. Haynes, of the Lick Observatory, has been made associate professor of astronomy at Beloit College and director of the Smith Observatory.

J. Crosby Chapman, B.A. (Cambridge), D.Sc. (London), Ph.D. (Columbia), has been elected assistant professor of experimental education of Western Reserve University.

Among the new faculty appointments at Oberlin College the more important are the following: Dr. H. N. Holmes as professor of chemistry and head of the department. Dr. Holmes received his A.B. from Westminster College in 1899 and the doctorate from Johns Hopkins in 1907. He comes to Oberlin from Earlham to succeed Professor Allen W. C. Menzies who goes to Princeton. Dr. H. A. Miller has been made professor of sociology and head of the department. Dr. Miller received his A.B. from Dartmouth in 1899 and his Ph.D. from Harvard in 1905. He comes from Olivet College. Dr. George R. Wells is promoted to be associate professor of psychology and Dr. E. M. Kitch enters the department of philosophy as associate professor after two years of study in the University of Chicago.

Changes in the scientific staff of the University of Idaho have been made as follows: Dr. Chester Snow, associate professor of mathematics; Dr. John J. Putnam, associate professor of bacteriology, in charge of the department; Associate Professor C. W. Hickman, department of animal husbandry; Mr. Newell S. Robb, in charge of the department of agronomy; Assistant Professor O. W. Holmes, department of dairying; Professor C. E. Coolidge, mechanical engineering; Professor A. M. Winslow, civil engineering, and Mr. L. W. Currier, metallurgy and geology department.

Mr. Stanley F. Brown and Dr. Wm. M. Thornton, Jr., have been appointed tutors in the department of chemistry, College of the City of New York.

Dr. J. E. Rowe, of Dartmouth College, has been appointed assistant professor of mathematics in the Pennsylvania State College.

Professor R. H. Yapp has been appointed professor of botany in the Queen's University, Belfast.

Mr. L. J. Goldsworthy has been appointed professor of chemistry at the Victoria College of Science, Nagpur.

DISCUSSION AND CORRESPONDENCE

AN EXPERIMENT ON KILLING TREE SCALE BY POISONING THE SAP OF THE TREE

I have in my grounds a plant of Spanish broom about a dozen years old and with a trunk about four inches in diameter which has for several years been seriously infested by cottony cushion scale (*Icerya purchasi*). I have tried various sprays, have put scale-eating beetles on the tree and at one time cut all the branches off and sprayed the trunk several times in the attempt to get permanently rid of this scale, but up to last winter it seemed that all attempts were in vain. In February of this year, when the broom was very thickly covered with the scale I bored a $\frac{3}{8}$ in. hole in the trunk to a depth of about three inches, filled the hole nearly full of crystals of potassic

cyanide and plugged it up. In two days the scale began to fall from the tree and in a few days all appeared dead. Others hatched and attacked the tree, but lasted only a short time, and the tree has since been free from scale and very vigorous.

At the same time I bored a similar hole in an old peach tree which seemed to have passed its usefulness and put a like charge of potassic cyanide in it. The tree has since seemed more vigorous than before, and raised a fair crop of peaches. After feeding some of them to chickens and a rabbit with no apparent ill result, I ate some of the peaches, and could find nothing wrong with them. I have since put a similar charge of the cyanide in an orange tree with no apparent bad effect.

It would seem from this experiment that it is possible in some kinds of trees, at least, to poison scale and sap-eating insects without injury to the tree. The method would seem to be especially adapted to killing various kinds of borers and insects which, like the pine beetles, burrow beneath the bark.

Fernando Sanford
Stanford University, Cal.,
September 3, 1914

LABORATORY CULTURES OF AMŒBA

To the Editor of Science: While *Amœba* may appear in hay infusions within five days, even when in sufficient quantity, it is often not desirable for laboratory study on account of its extremely small size. Again standard text-books of general biology give tolerably certain methods for obtaining the organism, within, however, a much longer time—in some cases from 5 to 6 weeks. The writer hopes that certain notes on this part of the laboratory routine may be of help.

In preparing laboratory cultures of *Amœba* during the past three years, he has been led to collect material for his infusions from a number of different types of environment—stagnant and freshwater ponds, swamps, sewage polluted streams, etc., and to make *composite* cultures of the material obtained. Such cultures, if not infertile, in the writer's experience rapidly attain the peculiar balance necessary for the flourishing growth of the organism, and yield in a comparatively short time, in one case as early as six days, a type of *Amœba,* which, if not always large, presents considerable advantage over that inhabiting the hay infusion. Such cultures have been available for study as long as eight days. Very frequently, too, there are produced an abundance of Spirillæ, etc., which the *Amœbæ* obligingly ingest, while the whole microcosm seems to be one superior to that obtained in the infusion as ordinarily made. A number of control cultures made at the University of Pittsburgh and the Osborn Zoological Laboratory, Yale University, showed that *Amœba* eventually appeared in one or more of the components of the composite culture, but in every case later. Without any attempt at explanation, it seems to the writer, that there may be some parallelism between the condition of environment obtained in such a composite culture and that in the "varied environment medium" as described by Woodruff.[1] In conclusion, it is noted that the results of the experiments have always remained fairly uniform, although widely separated geographical localities have been involved.

N. M. Grier
Biological Laboratory,
University of Pittsburgh

THE ORIGIN OF MUTATION

The word mutation appears to have suddenly arisen in 1650, according to Lock. It appeared again independently two hundred and nineteen years later. This recent advent (1869) has been termed the "Mutations of Waagen" (1912). Darwin at times spoke of species as "mutable," and de Vries (1901) has made the word famous.

Since in the pages of this journal and elsewhere in the States there has been an attempt to show that the word was preoccupied in a sense different from that in which de Vries used it, the following quotation from Lock, "Recent Progress in the Study of Variation, Heredity and Evolution,"[2] may be interesting.

1 *American Naturalist,* XLII.

2 Third edition, 1911, p. 124.

Perhaps the earliest use of the actual word "mutation" in this sense is to be found in "Pseudodoxia Epidemica," by Dr. Thomas Browne. I quote from Book VI., Chapter X., "Of the Blackness of Negroes":[2] "We may say that men became black in the same manner that some Foxes, Squirrels, Lions, first turned of this complection, whereof there are a constant sort in diverse Countries; that some Chaughes came to have red legges and bills, that Crows became pyed; All which *mutations*, however they began, depend upon durable foundations, and such as may continue for ever."

XY

PLEA FOR A STATUE IN WASHINGTON TO PROFESSOR SPENCER FULLERTON BAIRD

TO THE EDITOR OF SCIENCE: In Lafayette Square, opposite the White House in Washington, there are five statutes in bronze, all of heroic proportions. They are of military characters, only one of them being that of an American. Each commemorates deeds of war and bloodshed, and their accessories consist of the implements and munitions of warfare. In the various parts of this city, within and without the majority of the federal and municipal buildings, and in the museums, there are a great many statues—some in stone, some in metal—which have been erected to prominent characters in American history. A few of these are of foreigners, while the majority of them are of our own countrymen. In some instances, the same person had two or more such statues erected in his honor, while General Washington has apparently been favored with a half dozen or more.

Again, these duplications invariably have military men as their subjects; and the greater their exploits were in the way of leading men in battle, in which thousands of their enemies were slain, the more likely are we to find them thus distinguished. It is safe to say that at least eighty-five per cent. of all such statues to be found in the city of Washington are of military men; and it is truly discouraging, as well as disgraceful, to note how very few there are which have been erected to writers or to men of science in any of its many departments.

[2] Second edition, 1650.

On the Smithsonian grounds there is one to Professor Joseph Henry, and Doctor Samuel D. Gross has been similarly honored in a fine statue which appears on the grounds of the Army Medical Museum. A very few others are to be seen about the city or in the public buildings, not half a dozen altogether thus commemorating the works of any of our great astronomers, chemists, biologists, surgeons, artists, inventors and others who have long ago passed away, while their works and discoveries still redound to this nation's credit, advantage and welfare, and that with ever-increasing force and volume.

In line with the city's improvements, there has recently been formed a small, park-like, subtriangular square, at a point where, in the near future, there will be a grand entrance to the National Zoological Gardens. This is situated at the intersections of Sixteenth Street, Columbia Road and Mount Pleasant Street, in a section which promises some day to be one of the most attractive parts of the northwest part of the city.

There could be no better locality than this one, anywhere in the nation's capital, upon which to erect a statue to Professor Baird, nor could any one be selected, from among those who have gone before in science, to more appropriately occupy this spot than he.

Not only was Professor Baird largely responsible for the establishment of the National Zoological Gardens and Park; but, as every scientist is fully aware, from one end of the world to the other, he, of all others, did more during his lifetime to augment and build up American zoological science, to start and encourage the younger members of the profession, and withal to very materially add to the literature of biology as a whole, as he was the author and co-author of several formal volumes on natural history and of over a thousand papers on allied subjects. The establishment of the U. S. Bureau of Fisheries is almost wholly due to his energy and foresight; while as secretary of the Smithsonian Institution he has left a record which, for scientific achievement, enterprise and actual accomplishment, has never been in any way ap-

proached, and it will remain unique for many generations to come.

I am sure that the great body of scientific people of this country will be in full sympathy with the proposition here made, and it should not be a difficult matter to select and appoint a committee to carry it out successfully. The sanction of Congress can doubtless be readily secured, and the necessary means for the purpose easily obtained through subscriptions from American scientists and scientific institutions.

R. W. Shufeldt

Washington, D. C.

BELGIAN PROFESSORS AND SCHOLARS

To the Editor of Science: It would seem to me that the present time is a particularly appropriate one for our university administrators and other organizations having to do with educational exchanges with Europe to give a special consideration to professors in Belgium. It is well known that in the universities of that country there are many men eminent in the different departments of learning, and in the present necessarily deranged conditions in their own country, an opportunity to teach, or work in laboratories, in America might be particularly welcome. There could naturally be no thought of a completion of the exchange by sending Americans to Belgium at this time.

It might also be a useful thing if some of the generous benefactors of American institutions could establish at least temporary fellowships or scholarships in appropriate American institutions, carrying with them a stipend fully sufficient for academic, traveling and living expenses, for the benefit of young Belgians whose studies are interrupted by the war and who are not called to take arms in behalf of their country.

Edwin B. Frost

Yerkes Observatory,
September 30

SCIENTIFIC BOOKS

The Middle Triassic Marine Invertebrate Faunas of North America. By James Perrin Smith. U. S. Geological Survey, Professional Paper No. 83. Washington, Government Printing Office, 1914. 4°. Pp. 254, pl. I–XCIX.

Many years ago the author of this paper planned, with Professor Alpheus Hyatt, a monographic treatment of the Triassic invertebrate faunas of America. As time went on it became evident that Professor Hyatt's other engagements would prevent the carrying out of this plan. With his advice and assistance Professor Smith prepared a synoptic introduction to the Cephalopod fauna, issued as U. S. Geological Survey Professional Paper No. 40.

As the work went on it became evident that the material would be too bulky for a single volume, so the Upper, Middle and Lower Triassic were planned to occupy each a single volume.

That the Middle Triassic part is now first published follows from the fact that the manuscript was nearer completion than the others and contains more new material. The classification is that of the synoptic introduction above cited and is not repeated in detail in the present volume.

The Middle Triassic fauna consists in the main, as here shown, of Cephalopoda, with a few bivalves, brachiopods and echinoderms, but not a single gastropod.

Marine fossils of the Middle Triassic, according to Professor Smith, are known in North America, only from California, central Nevada and British Columbia. The Triassic of the eastern states is all nonmarine. The continental deposits of Western America appear to have resulted from arid conditions, but the fossils of the marine sediments were laid down in an arm of the ocean and not in a closed basin like the Caspian Sea. This is indicated by their close relation, faunally, to those of the other Pacific borders and to the ancient sea which in Mesozoic time covered a large part of southern Asia. The Middle Triassic of Western America is divided into two zones, the lower having a mixture of boreal and East Indian types and called after its zone-fossil, *Parapopanoceras;* the upper, with a Mediterranean fauna, plus

some East Indian types and taking its designation from the bivalve *Daonella dubia*.

A certain kinship still exists between the Middle Triassic faunas of western America and Asia, due perhaps to common descent as much as to migration. The relationship with the Eurasian Mediterranean or "Tethys" fauna begins to be strong, especially among the Ceratitidæ. In the west Humboldt range of Nevada about twenty-five per cent. of the species are either identical with, or closely related to forms of the same age in the Mediterranean region. The faunas of the latter and of America are more closely related to each other than either is to the boreal or to the East Indian fauna. These propositions are exhaustively illustrated by tabulation of the species. A full bibliography of the subject is given, followed by descriptive matter which contains comparative data of great value, the more welcome because so seldom furnished by authors. The plates are admirable and the typography such as usually comes from the Government printing office. It may save some student time to know that "Plate one" on pages 144 and 145, should read "Plate fifty." W. H. Dall

Monograph of the Shallow-water Starfishes of the North Pacific Coast from the Arctic Ocean to California. By Addison Emery Verrill. Harriman Alaska Series, Volume XIV. City of Washington. Published by the Smithsonian Institution. 1914. Large octavo, 2 vols., text (xii + 408 pp.) and plates (110).

For many years the remarkable starfish fauna of the west coast of America has occupied a large part of Professor Verrill's time and attention, and these two fine volumes are the result of his study. The short preface recounts the varied sources of his material, which was very extensive and included nearly all of the important collections on the American continent. The original material on which Dr. William Stimpson based his species is fortunately still extant and the reproduction of photographs of many of his types is one of the notable features of Professor Verrill's book.

A large part of the material incorporated in the "Introduction" (pp. 1–19) has been published by the author previously in articles in scientific periodicals, but considerable new matter is also included. The whole makes up a very interesting, though somewhat fragmentary account of habits, senses, variability and other characteristics of starfishes in general and of the west coast starfishes in particular. The general morphology of the Asterioidea is then taken up (pp. 20–24) and naturally, the classification of the group is next discussed (pp. 24–26). The family Asteriidæ, which occupies more than two-fifths of the entire volume, is then treated in considerable detail; the morphology requires more than ten pages (27–39); the classification and the discussion of various genera and subgenera, many new, occupy pages 40–56; and a very detailed but useful key to west coast species of Asteriidæ fills pages 57–67.

There then follows (pp. 67–202) the full and often elaborate account of these species, beginning with the well-known *Pisaster ochraceus* (Brandt). It is interesting to note that Verrill makes the families Stichasteridæ and Heliasteridæ, as recognized by most former workers, subfamilies of the Asteriidæ, a change which is almost certainly in the right direction. The old, familiar genus *Asterias*, which others have sought to subdivide but generally on trivial grounds and with poor success, Verrill boldly transforms into the subfamily Asteriinæ, and divides, on more or less important morphological grounds, into more than twenty genera. It is greatly to be regretted that nowhere does Verrill bring his proposed genera together in an analytical table or key, for it is by no means easy to determine what the interrelationships of his groups are. There can be little doubt that many of these groups are valid genera, but it is hard to believe that all are. The difficulty of comprehending Verrill's opinions regarding the groups is complicated by the use of "subgenera" and "sections," which certainly seem superfluous, when one old, long-recognized genus is split into more than twenty!

In his treatment of species, too, Professor

Verrill must plead guilty to being a "splitter." He himself says that he has added "thirty additional species" of *Asterias,* in the old, broad sense, to "over twenty" previously known from the Northwest Coast, "besides twenty well-marked new varietal forms, or a total of about seventy." In fact, the free use of both subspecies and varieties has led to a regrettable complexity of nomenclature, which is at times almost if not quite quadrinomial. Thus we have the starfish *Leptasterias epichlora,* with four subspecies, under one of which, *alaskensis,* two varieties are recognized *carinella* and *siderea,* and we must therefore speak of these starfishes by means of *four* names. There are further three varieties listed (p. 139) regarding which we are not told of what they are varieties, so we do not know whether they are to be designated by three names or by four. The distinction between subspecies and varieties is not clearly made. On page 17, we are told that subspecies are "bathymetrical or geographical races," but on page 133 the range of *Leptasterias epichlora* is given as from Vancouver to Yakutat and Dutch Harbor, while on page 137, the range of the subspecies *alaskensis* is said to be practically the same. On page 138, *miliaris* is said to be a new subspecies, but throughout the description is referred to as a variety. Under the head of varieties, Verrill includes (p. 17) "local variations due to unfavorable environments, sports, freaks, or hybrids." And to these he thinks it necessary or at least desirable to give distinctive names. Of course, these matters are largely governed by individual judgment, but it can not be denied that such splitting tremendously complicates the task of mastering the group in which it is done. The present reviewer considers it both unnecessary and undesirable.

Including all of his new species, subspecies and varieties, Verrill publishes in this volume, some seventy new names. (Many have been previously printed in a couple of preliminary papers.) These names are as a rule well chosen, euphonious and distinctive, indicating some peculiarity of the form. Only nine are names of persons, but eleven are geographical. There are also no fewer than seventeen new generic names proposed, all of which are worthy of commendation.

The northwest coast starfishes, not Asteriidæ, are discussed very fully in the section pages 202 to 336. Such difficult genera as *Henricia* and *Solaster* are treated with skill and good judgment and much light is thrown on the interrelationship of the species in each genus. The section also includes much important morphological material and the discussion of many nomenclatural questions. In his treatment of these questions, Professor Verrill reveals not only a very extended knowledge of the subject, but a delightfully catholic and unprejudiced spirit. On nearly all important points Verrill finds himself in accord with the conclusions of Fisher, and even when he feels obliged to disagree with that writer, the disagreements are always most courteously expressed. The spirit in which all controverted points are discussed is one of the most admirable features of the book.

The section on geographical distribution (pp. 337–373) falls naturally into two parts. The first deals with the region extending from southern California to the Arctic Ocean. Four distinct, though more or less overlapping, faunæ are recognized, the species belonging to each being listed. The interrelationships of these faunæ, as well as their relation to those of other regions, is fully discussed. The second part of the section deals with the starfishes of southern South America, and also includes a long list of other extralimital starfishes, which are partially "described, revised or figured" in the work. The account of South American species includes important changes in nomenclature, descriptions of new genera and some discussion of the relationship of these genera to those of the north. A complete list of all the new genera proposed in the volume is given on page 374, and following that is an extended bibliography (pp. 374–388). A very satisfactory index completes the volume (pp. 389–408).

Professor Verrill is certainly to be congratulated upon the completion of this important work, which has occupied him for several

years. It will long be a standard reference book for the region it covers, while many of the analytical tables and keys will be of use elsewhere. The illustrations, particularly the volume of plates, are very fine and of inestimable value. It is rare indeed that better photographs of starfishes are seen. The Harriman Alaska Expedition did much to advance our knowledge of the zoology of the northwestern American coast, and the volumes containing its results are notable for contents and appearance alike. But among them all, none take a higher rank or make a better impression than do these volumes on the starfishes, by the Nestor of American systematists.

Hubert Lyman Clark
Museum of Comparative Zoology,
Cambridge, Mass.,
June 17, 1914

The Weather and Climate of Chicago. By H. J. Cox and J. H. Armington. Bulletin 4. The Geographic Society of Chicago.

The authors, for many years official forecasters at Chicago, are to be congratulated upon the completion of a laborious piece of self-imposed work. The volume is essentially the station Means Book *in extenso* with stress laid upon unusual and extreme conditions. Reading between the lines, one is conscious of the effort to deduce definite laws bearing upon forecasting, but the hope is not realized and indeed we are told that "careful examination fails to afford any clue by which the nature of a season or year may be foretold, from any of its predecessors."

The discussion of temperature occupies 148 pages, with 44 tables and 30 figures. Nowhere is there given an equivalent value in Absolute or Centigrade degrees. The mean annual temperature determined from doubtful records dating back to 1830, is 282° A. (48° F.), which does not differ greatly from the mean obtained from the official records, 1871–1910. The latter, however, are of somewhat doubtful value since they were made at no less than seven different localities. The table of daily normal temperatures on page 33 leads us to infer that the normals used by the Weather Bureau cover a period of 32 years only, while data for 42 years are at hand.

The highest temperature officially recorded is 312° A. (103° F.), and the lowest 242° A. (— 23° F.). The year 1911 was the warmest since the establishment of the office, if we accept the Federal Building records without correction. On 22 days the temperature reached or exceeded 305° A. (90° F.). This record was equaled in 1913. The greatest daily range was 290°–261° A. (62°–10° F.) which actually occurred between the hours of eight A.M. and midnight.

In discussing the effect of winds from Lake Michigan it is stated "the specific heat of air being less than one quarter that of water, the interchange of heat will result in a larger change of air temperature than of water temperature."

The meaning is not quite clear, but it should be remembered that while the specific heat of air (at constant pressure?) is 0.24, the specific heat of water vapor is twice this, and it is water vapor rather than air or water which is the effective temperature control. The cooling effect is noticeable at times far inland, but in general decreases rapidly with distance, often disappearing within 15 or 20 miles. The wind records need not, however, be taken too seriously, since the type of instrument used by the Weather Bureau gives only eight points of the compass, *i. e.,* one direction covers 45 degrees. A shift of 22 degrees could not be detected. Again, the elevations have been changed a number of times, making the velocities uncertain. Calculated on the basis of hourly frequency, northeast is the prevailing wind. The highest daily wind, 2,167 kilometers (1,347 miles), occurred at the Auditorium Tower, but the highest recorded at the present location is only 70 per cent. of this. The authors think that the present velocities should be increased 10 per cent. to be comparable.

The precipitation records likewise are open to criticism, owing to faulty exposures and frequent changes. The authors frankly state that the effect of the poor conditions at the Auditorium Tower can not be questioned.

Apparently Chicago receives the same precipitation as the surrounding prairie region. Unfortunately no hourly readings of relative humidity are available and the period of bi-hourly values shown in Table CXII. is much too short to establish with any degree of accuracy values for the various hours. A table of average monthly and annual relative humidities for 15 cities in the United States is given, but no mention made of corresponding temperatures. As it stands, the table is without value for comparative purposes.

The authors give generous credit to all who have helped in the work. The Geographic Society of Chicago has done well in making accessible data which otherwise might have remained buried in official files. The general make-up of the book is good.

Alexander McAdie

Blue Hill Observatory

SPECIAL ARTICLES

SOME OBSERVATIONS ON THE FOOD HABITS OF THE SHORT-TAILED SHREW (BLARINA BREVICAUDA)

Of the six species of short-tailed shrews of the genus *Blarina* occurring in the United States, *Blarina brevicauda,* called the large blarina or mole-shrew, is the only one found north of the Austral region, and consequently is the only representative of the genus here in Massachusetts. It inhabits deciduous woodlands and fields, where it makes shallow tunnels that are often marked on the surface by little ridges.

This shrew is described as follows on page 11 of North American Fauna No. 10, U. S. Dept. of Agriculture:[1]

> General characters.—Size, largest of the subgenus (total length about 125 mm.); skull largest and heaviest of the American Soricidæ; pelage glossy. Color.—Sooty-plumbeous above, becoming ashy-plumbeous below, varying with the light; paler in summer; glossy in fresh pelage.

It has a stout body, nose rather long and tapering, external ears not visible, eyes very small, front teeth chestnut colored at tips, and tail about one quarter the length of the head and body. It depends on the highly specialized senses of touch, hearing and smell for guidance in probing about and searching for food, the eyes being very slightly developed.

General works on natural history speak of the diet of shrews as being chiefly worms, larvæ of insects and small mollusks.

Audubon and Bachman,[2] in speaking of the Carolina shrew (*Blarina brevicauda carolinensis*), an animal somewhat smaller than the short-tailed shrew, say:

> In digging ditches and ploughing in moderately high grounds, small holes are frequently seen running in all directions, in a line nearly parallel with the surface, and extending to a great distance, evidently made by this species. We observed on the sides of one of these galleries a small cavity containing a hoard of coleopterous insects, principally composed of a rare species (*Scarabœus tityns*) fully the size of the animal itself; some of them were nearly consumed, and the rest mutilated, although still living.

Merriam[3] says that "it subsists upon beechnuts, insects, earthworms, slugs, sow-bugs and mice." He also speaks of its feeding on chrysoledes and the larvæ of insects. He quotes Mr. John Morden, in the *Canadian Sportsman and Naturalist,* Vol. III., 1883, in which the latter describes the mouse-killing and eating propensities of the short-tailed shrew and draws these conclusions:

> According to my observations, the little mammal under consideration eats about twice or three times its own weight of food every twenty-four hours, and when we consider that their principal food consists of insects, it is quite bewildering to imagine the myriads one must destroy in a year.

Merriam proceeds to tell of an encounter between a short-tailed shrew weighing 11.20 grams and a deer mouse (*Peromyscus leucopus*) weighing 17 grams, in which the former was victorious, and after eating an ear, the brains, side of the head and part of the shoulder of the mouse, weighed 12 grams. He says:

[1] U. S. Dept. Agriculture, North American Fauna Series No. 10, p. 4, 1895. "Revision of the Shrews of the American Genera *Blarina* and *Notiosorex,*" by C. Hart Merriam.

[2] Audubon and Bachman, "The Quadrupeds of North America," 1849.

[3] Merriam, "The Mammals of the Adirondack Region," 1884.

If left without food for a few hours he will eat corn from the cob, beginning at the outside of the kernel, but it is very clear that he does not relish his fare. He will also eat Indian meal and oats when other food is not at hand. Slugs and earthworms he devours with avidity, always starting at one end, and manipulating them with his fore paws. But of the various kinds of food placed before him, he shows an unmistakable preference for mice—either dead or alive.

Rhoads[4] writes:

It is known that they (*Blarina brevicauda*) subsist to some extent on vegetable food, chiefly nuts, but they do only indirect damage to agriculture by disturbing the roots of plants.

He also states that they eat "salamanders, other batrachians, and reptiles which haunt their burrows."

Shull[5] found that this shrew eats house mice, May beetles (*Lachnosterna*) and their grubs, moth larvæ, other insects and pupæ, earthworms, snails of the genus *Polygyra*, sow-bugs and beef. "Carrots, crackers, roots of grasses and other plants," he says, were never touched as food.

Stone and Cram[6] relate the following observation:

One that I caught in a trap had already, when I found it, disposed of the raw meat which had served as bait, and when confined in a cage immediately seized upon whatever meat was offered it, whether raw or cooked, without discriminating between kinds. Beef, pork and cold chicken—all went the same way, while the fury of his appetite was being appeased.

They also write:

I believe that they get the greater part of their food at this season (winter) by burrowing about among the dead leaves beneath the snow in the forests, gathering the dormant insects that habitually pass the winter in such places.

Seton[7] states that the diet of the short-tailed shrew is chiefly insects and worms, but that it will eat "any kind of living food it can find and master, preying largely, . . . on field mice, which equal or exceed it in weight." He believes dormant insects form a large part of its sustenance in winter. He gives the following list of stomach contents findings from short-tailed shrews, taken at Cos Cob, Connecticut:

No. 1. Earthworms, almost whole; membranous wings of beetle.

No. 2. Connective tissue, cartilage and muscle.

No. 3. Earthworm setæ, parts of insects; some of its own hair, probably swallowed with food.

No. 4. Earthworms.

No. 5. Earthworm setæ.

No. 6. Insects.

No. 7. Insects.

No. 8. Legs of Isopod.

No. 9. Muscles and setæ of earthworms.

No. 10. Earthworms.

No. 11. Earthworms and insects.

No. 12. Isopod legs and insects.

No. 13. Earthworms, insects, connective tissue and striated muscle, probably of some small rodent.

Shull reports the findings of two stomach contents as follows:

1. An insect larva.
2. Meadow vole.

In speaking of the short-tailed shrew, Corey[8] quotes Dr. John T. Plummer[9] as follows:

It was given flesh of all kinds, fish, coleopterous as well as other insects, corn, oats and other kinds of grain, all of which appeared to be acceptable food. "The corcle of the grains of maize was always eaten out, as it is by rats and mice." When water was put into the box the shrew "wet his tongue two or three times and went away; but when worms were dropped into the cup, he returned, waded about in the water, snatched up his victim, maimed it, stored it away, and returned repeatedly for more till all were secured." A full-grown living mouse was put into the box, which was at once fiercely pursued by the shrew, attacked and killed. Another mouse met with the same fate.

This habit of attacking mice is well known among those who have studied into the matter. Merriam and Morden have vividly described

[4] Rhoads, "The Mammals of Pennsylvania and New Jersey," 1903.

[5] Shull, "Habits of the Short-tailed Shrew, *Blarina Brevicauda* Say," *American Naturalist*, Vol. XLI., No. 488, pp. 496–522, August, 1907.

[6] Stone and Cram, "American Animals," 1905.

[7] Seton, "Life Histories of Northern Animals," 1909.

[8] Corey, "The Mammals of Illinois and Wisconsin," Publication 153, Zool. Ser., Vol. VI., Field Museum of Natural History, Chicago, Ill., 1912.

[9] *Am. Jour. of Sci.*, Vol. XLVI., 1884.

such encounters, but Kennicott[10] is the only writer who has described an encounter in which the shrew was attacked by the mouse. He says: "When attacked by a meadow mouse (*Arvicola scalopsoides*), etc. . . ." Shull states, in speaking of short-tailed shrews kept in confinement, that house mice were captured when they entered the shrews' burrows, while voles were pursued and cornered above ground, and that most of the killing was done at night.

While the observations referred to above were regarding house mice (*Mus musculus*), meadow mice (*Microtus pennsylvanicus*) and white-footed or deer mice (*Peromyscus leucopus*), the writer found that red-backed mice (*Evotomys gapperi*) were no exception, for on two occasions a short-tailed shrew which the writer had under observation, overcame and killed a red-back without apparent injury to itself. Morden states that it took about ten minutes for a short-tailed shrew to overcome and kill a meadow mouse larger than itself, and Merriam found his 11.2 gram shrew was half an hour in tiring and half an hour in killing a 17-gram deer mouse. In the encounter witnessed by the writer, it required twelve minutes for the shrew to kill the mouse after getting its first hold. On another occasion the shrew, which weighed 15 grams, captured and killed during the night a red-backed mouse, weighing 29 grams and seemed uninjured after the encounter.

It is difficult to conceive how a shrew, with its very limited vision (the eyes being probably of service only in distinguishing light from darkness) can capture an uninjured mouse in the freedom of the woods (the box in which the shrew and mice were confined was 18 in. $\times$ 20 in.) yet this shrew had a systematic method of attack, and always opened the skull of its victim in the same general location, which would seem to indicate that it had had experience in such encounters, or else had acquired the knowledge by heredity, which would also indicate a long series of such battles by its ancestors. An exception to its habitual method of opening the skull was observed one day when an adult Norway rat (*Epimys norvegicus*) freshly killed, was placed in the box. Instead of entering the cranial cavity between the eye and ear, as usual, it opened the throat and worked into the brain through the base of the skull.

An interesting habit which this shrew exhibited, and which may illustrate one method of capturing mice under natural conditions, was noted as follows: Whenever a live mouse was placed in the box with the shrew, the latter at once secreted itself under some small pile of leaves or moss. In the course of a few minutes the mouse, while exploring its new quarters, would jump on the pile under which the shrew was concealed, whereupon the shrew would spring up and try to get hold of the mouse. This was attempted on several occasions, always, however, without success.

Animal food in any form seemed acceptable, while only a limited variety of vegetable matter was eaten. It ate grasshoppers (*Melanoplus femoratus*) and crickets (*Gryllus* Penn.) with avidity; raw beef sparingly, preferring the fat; and small amounts of American cheese. One morning when no other food was at hand, it devoured the abdominal contents of another shrew of the same species, freshly killed. As soon as other food was placed in the box, however, the remains of the dead shrew were at once and permanently deserted, which would indicate that this animal did not become cannibalistic except under stress of circumstances. In speaking of this habit it may be of interest to quote Merriam's observations on the long-tailed shrew (*Sorex personatus*), a much smaller animal. He writes,

> I once confined three of them under an ordinary tumbler. Almost immediately they commenced fighting, and in a few minutes one was slaughtered and eaten by the other two. Before night one of these killed and ate its only surviving companion, and its abdomen was much distended by the meal. Hence, in less than eight hours one of these tiny wild beasts had attacked, overcome and ravenously consumed two of its own species, each as large and heavy as itself!

Another shrew under observation devoured

[10] Kennicott, Report of the Commissioner of Patents for 1857. Agriculture, "The Quadrupeds of Illinois Injurious and Beneficial to the Farmer."

a small garden toad, but allowed a large one (40 grams est.) to remain in the box for five hours unmolested, at the end of which time the toad was removed.

Professor Cope[11] writes of a Carolina shrew overcoming a water snake (*Tropidonotus sipedon*) two feet in length, in a night, which shows the courage and fighting qualities of this little beast.

To test the keenness of the senses of this shrew, a skin of a meadow jumping mouse (*Zapus hudsonius*), dried some months previously, was placed in the box. It was at once furiously attacked, but was removed as soon as torn about the head, because of the presence of white arsenic inside. So vigorous was the attack that the mouse skin was repeatedly lifted from the floor with the shrew still clinging on, biting and tearing. It would have been interesting to see how long the ill-directed attack would have been continued.

Moles and shrews have been often accused, by farmers especially, of being agents of destruction about gardens and of subsisting on the vegetable food found there. In all probability the only damage committed, by this species of shrew at least, is done indirectly, as referred to above, by disturbing roots while burrowing about for insects or worms. The following experiment, which bears on this matter, was carried out with the same results on two different occasions. The box being cleared of all food, the following twenty-one varieties of common vegetable matter, most of it freshly gathered, were put in: cabbage, cauliflower, lettuce, potato, carrot, parsnip, string-bean, pole-bean, summer squash, turnip, beet, sweet corn, rhubarb, kohlrabi, tomato, cucumber, peach, pear, canteloupe, banana and olive. At the end of nine hours (first experiment), the shrew was found curled up in one corner of the box, weak and listless, while not one of the vegetables had been touched, with the exception of the olive, which had been nibbled. (This may have been eaten to get the salt, as the olive had been kept in brine.)

[11] Cope, "On a Habit of a Species of *Blarina*," *Am. Nat.*, Vol. VII., No. 8, pp. 490–491, Aug., 1873.

When the experiment was tried the second time, the shrew remained eleven hours without food, and showed quite a marked constriction about his abdomen at the end of that time. These results seem to vindicate the short-tailed shrew from the charge of being a garden thief.

An exception to its non-vegetarian habits, however, was found to be made in regard to rolled oats. These it ate at first sparingly and with little relish, but later lived on them exclusively for fifty-two hours and at the end of that time seemed as vigorous and contented as ever. Seton speaks of taking a female short-tailed shrew whose stomach was full of corn meal unmixed, and owing to the unusually slow process of putrefaction in the animal, he reasons that it had been on that diet for some time. Merriam writes of one he had in confinement that was "very fond of beechnuts and thrived when fed exclusively on them for more than a week." Judging from these findings, dry vegetable food seems to be preferred to succulent varieties.

The writer's shrews did not exhibit the ravenous appetite attributed to the species by some observers. They did not pursue their prey persistently, and having captured it, seemed satisfied, for the time being, with a small amount of food. Shull gives two thirds of a meadow vole or one house mouse as the average daily diet. This is a higher average than that made by the shrews under observation, as two thirds of a house mouse, or its equivalent, was amply sufficient. They drank small quantities of water frequently. However, within the twelve hours immediately following an eleven-hour fast, one ate 16 grams of animal food (more than the equivalent of its own weight—15 grams), which fact demonstrates their latent capabilities in that direction. Quoting Seton again, he says:

> Numerous experiments and observations on captive animals prove that the *Blarina*, like its smaller kin, has an enormous appetite which must be satisfied, or in a very few hours the creature succumbs.

The writer found an uninjured shrew of this species, dead in a cage trap seventeen hours after setting it, showing that death by starva-

tion took place in something less than that time.

The favorite diet of the animals under observation was, without question, freshly killed mice. Shull, estimating four of these shrews to the acre, figured that on a farm of one hundred acres, they would, in a year, devour 38,400. Realizing the vast amount of damage these rodents are capable of producing in agriculture and considering also the almost exclusively carnivorous habits of the *Blarina brevicauda*, one must admit a great economic value for this shrew.

H. L. BABCOCK

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THE LIMIT OF UNIFORMITY IN THE GRADING OF COLLEGE STUDENTS BY DIFFERENT TEACHERS[1]

IN the University of Missouri our grades have, since five years ago, been defined by the frequencies of their permitted occurrence: according to our definitions 25 per cent. are superior, 50 per cent. medium and 25 per cent. inferior grades.[2] We hoped thereby to diminish or even exterminate the divergence of marking then existing. We actually reduced this divergence; but only two thirds. We failed to exterminate it. One third of the former lack of uniformity persists, as may be seen from my previous report in SCIENCE, and we ask the question: Why does it persist?

It seems that the chief cause is the inability (call it unwillingness, if you wish, but nothing is gained by any name) of the teachers to differentiate between the performances justly to be expected of a freshman and a senior. For simplicity's sake I speak of two college classes only. Instead of recognizing the relatively superior work of certain freshmen among the freshmen, the teacher compares their work with the work of seniors, and then, of course, finds it to be but weak. And, instead of recognizing that some of the seniors are much less accomplished than other seniors, the teacher compares the weaker senior's accomplishment with that of the freshman and finds it quite remarkable. The result is a widely spread tendency of teachers to report an excess of inferior grades in freshman classes and an excess of superior grades in senior classes. This seems to explain that persistent fraction of the lack of uniformity which we could not eradicate.

Here is the example of an individual teacher in history whose total distribution of grades is approximately that prescribed by the university:

	25% Sup.		50% M.	25% Inf.	
	%E	%S	%M	%I	%F
Underclassmen	1	16	51	25	7
Upperclassmen	6	30	40	20	4

Is there any remedy? It seems simple. Let the teacher differentiate more between the work of freshmen and that of seniors. Assign to the freshman such tasks as are appropriate to the condition of the student who has just left the high school, and to the senior tasks which approach in difficulty, in the requirement of initiative, of resourcefulness, the tasks which the research work of the graduate school keeps ready for the senior as soon as he has his diploma.

But this remedy is not as simple and easy of application as it looks, for the average college teacher seems to be incapable of making the differentiation required. Instead of comparing, rather, freshmen with high-school pupils and seniors with graduate students, he compares freshmen with seniors in the performance of an identical task given to both. However, we must have patience with the teacher. His own task is not small. There are three influences from which he can not easily free himself. (1) Freshmen and seniors, after all, belong socially to one group, that of college students, and neither to the group of high school pupils nor to that of members of the graduate school. (2) He is in mental contact with both freshmen and seniors all the time, but usually no longer with high school pupils and not, probably, with graduate

1 Read before Section L—Education—American Association for the Advancement of Science, Atlanta, December, 1913.

2 Compare two former papers: "The Grading of Students," SCIENCE, 28, pp. 243–250, 1908; "Experiences with the Grading System of the University of Missouri," SCIENCE, 33, pp. 661–667, 1911.

students either. (3) He probably has, frequently, in the same class both freshmen and seniors taking together exactly the same course, and then he can hardly be blamed for comparing their work, even though in the abstract he ought not to compare it. If we want to solve the problem, we have to free the teacher who, usually, is incapable of freeing himself, from these three influences. And that looks like an almost hopeless problem. But, meanwhile, let us not forget that two thirds of the lack of uniformity in grading among teachers can be removed, and that this can be done easily and simply by proper definitions of the grades, for example, by those definitions which we have used in Missouri.

I have now practically said what I wanted to say. If I continue, it is for the illustration of special points rather than for the statement of any additional principle. Let me recall the remark that the tasks to be assigned to seniors, or to members of both upper classes, ought to approach in the requirement of initiative, of resourcefulness, of originality the tasks which the research work of the graduate school places upon its students. I here wish to make it clear that the average college teacher may be expected to offer stubborn resistance to such a demand. For the illustration of the fact that the work assigned to upper classmen generally approaches, in the lack of any requirement of resourcefulness, the work of the high school rather than that of the graduate school, let me refer to data which, at the first glance, seem to be unrelated to the question, but which nevertheless illustrate it well. I am thinking of the high marks obtained by the women students in coeducational institutions. In the University of Missouri we find for the first semester 1912/13 the following record:

Grade Hours		Per Cent. Superior	Per Cent. Medium	Per Cent. Inferior
22,000	Men	23	53	24
7,000	Women	29	55	16

I suppose that the purpose of college training is to prepare students to meet more proficiently all the varied demands which society later will make upon them,—as the common phrase is, to make better men and better women of them. According to the college records one should expect that women rather than men would be found to be the leaders of human society. As a matter of fact there are but few women among the leaders of mankind even in this decade of this century. I recognize, of course, that women are handicapped by three conditions, by legal discriminations, by the force of tradition, and especially by the obstacles resulting from motherhood. No one, however, would assert that, these obstacles being removed, the women would surpass the men in the leadership of society. There is, then, something wrong in such college records which bluntly state that college women are better prepared for leadership in human life than college men. What is wrong in these records is obviously the result of the teachers giving the wrong kind of a test. Instead of testing the initiative which the student should have been trained to put into action for the solution of a certain kind of problems, the teacher tests almost exclusively that kind of accomplishment which depends on the degree of faithfulness and regularity in the performance of assigned tasks. We need not be astonished that the average teacher does not and really can not give the former kind of test, the test of "initiative put into action." Educational science is still so undeveloped that in many subjects the teacher himself does not know how to give such a test. And then—he who tests initiative has to employ initiative himself in the act of testing. That requires an immensely greater effort on the part of the teacher than to test, in the traditional way, how faithfully the students have done their assigned work, and so we can hardly expect the teacher, already overworked, to put himself under the strain resulting from a more proper method of testing.

The same conditions apply to the testing of freshmen and seniors. The seniors, being only one step removed from graduate students, ought to possess a comparative degree of initiative. But their examinations are conceived more like those of college freshmen

than like those of beginners in graduate work. The teacher thus develops in himself the illusion that his average senior, however illogical this is, stands above the average of his own group, and that all the seniors deserve unusually high marks, that is, in comparison with freshmen. But let these seniors enter the graduate school, and some of them will be found, by the different kind of test there employed, to be almost incapable of doing any graduate work at all, because they are deficient in originality, initiative, resourcefulness, whatever you call it, in their chosen line.

This tendency to compare freshmen and seniors is so deep-seated that there is no hope of eradicating it by simply calling attention to it. As in college, so you find it in the high school. My former colleague in Missouri, Professor C. Alexander, found in an (unpublished) investigation of the grading of high schools, that the freshmen are reported partly as average scholars, partly as superior, and partly as inferior; but the seniors, there, too, are reported mostly as high-grade scholars. The low-grade scholars are said to have been eliminated. Now some of these high-grade scholars, obviously not the worst, enter the state university. One should think, then, that our college teachers in the freshmen classes would find it a difficult task to separate from this whipping cream any more plain milk. But the contrary is true. Our teachers complain constantly of the poor scholarship of these "selected" college freshmen.

All this shows, by the way, how unfounded the statement is which we hear again and again that the normal, *i. e.*, symmetrical, curve of distribution is inapplicable to college students because they are supposed to be a selected group. Only then would the symmetrical curve of distribution be inapplicable, if the college freshmen under consideration had been selected by freshmen tests from college freshmen, or if the college seniors had been selected, by tests appropriate to seniors, from the entire group of seniors. There is no reason why the symmetrical curve should be inapplicable to the entire group of freshmen, or to the entire group of seniors, or to the entire group of graduate students or to any group, provided only that the group is complete as a group. That the group came into existence by selection from a different group does not seem to matter when each new group is confronted with new kinds of tasks. There are those who say that it is easy to prove, by examination tests of the ordinary, traditional type, that college students must be regarded as a selected class[3] in the sense that their distribution is not represented by a symmetrical, but by a skewed curve. I have already, a few years ago, called attention to the fact[4] that such examinations are unreliable. Simply make the examination difficult and set a time limit; the curve appears skewed one way, most of those tested crowding in the direction of low ability. Make the examination easy and abolish or greatly extend the time limit; the curve appears skewed the other way. I offer to prove at will by an examination left to my choice that any group of students is distributed either way. Just tell me in advance which way you want the curve skewed.

For the practical problems of college administration this question as to the exact nature of the curve of distribution is really of minor importance. If, however, we just have to make an assumption, it is safest to assume the symmetrical normal distribution. We have assumed in Missouri that the distribution is either normal or very nearly so and experienced no inconvenience. We have reduced the lack of uniformity between teachers to one third of its former amount simply by the adoption of scientifically justifiable definitions, and a reduction to that amount is worth while. But to eradicate the last third is a complex problem of the future, so complex that it may never be completely solved. As has been indicated, it seems to involve problems of our whole educational system and even of the broader social organization of the nation.

MAX MEYER

3 Compare the two tendencies, conflicting with each other, according to Cattell, *Popular Science Monthly*, 1905, p. 372.

4 SCIENCE, 33, p. 667, 1911.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE EARTH'S CRUST[1]

The idea of the greater inequalities of the globe being approximately static equilibrium has been recognized for many years: it was expressed by Babbage and Herschel; it was included in Archdeacon Pratt's theory of compensation; and it was accepted by Fisher as one of the fundamental facts on which his theory of mountain structure rested. But in 1889 Captain C. E. Dutton presented the idea "in a modified form, in a new dress, and in greater detail"; he gave the idea orthodox baptism and a name, which seems to be necessary for the respectable life of any scientific theory. "For the condition of equilibrium of figure, to which gravitation tends to reduce a planetary body, irrespective of whether it be homogeneous or not." Dutton[2] proposed "the name *isostasy*." The corresponding adjective would be isostatic—the state of balance between the ups and downs on the earth.

For a long time geologists were forced to content themselves with the conclusion that the folding of strata is the result of the crust collapsing on a cooling and shrinking core; but Fisher pointed out that the amount of radial shrinking could not account even for the present great surface inequalities of the lithosphere, without regard to the enormous lateral shortening indicated by the folds in great mountain regions, some of which, like the Himalayan

[1] Concluding part of the address of the president of the Geological Section of the British Association for the Advancement of Science, Australia, 1914.

[2] Dutton, "On Some of the Greater Problems of Physical Geology," *Bull. Phil. Soc. Wash.*, XI., 53, 1889.

folds, were formed at a late date in the earth's history, folds which in date and direction have no genetic relationship to G. H. Darwin's primitive wrinkles. Then, besides the folding and plication of the crust in some areas, we have to account for the undoubted stretching which it has suffered in other places, stretching of a kind indicated by faults so common that they are generally known as normal faults. It has been estimated by Claypole that the folding of the Appalachian range resulted in a horizontal compression of the strata to a belt less than 65 per cent. of the original breadth. According to Heim the diameter of the northern zone of the central Alps is not more than half the original extension of the strata when they were laid down in horizontal sheets. De la Beche, in his memoir on Devon and Cornwall, which anticipated many problems of more than local interest, pointed out that, if the inclined and folded strata were flattened out again, they would cover far more ground than that to which they are now restricted on the geological map. Thus, according to Dutton, Fisher, and others, the mere contraction of the cooling globe is insufficient to account for our great rock-folds, especially great folds like those of the Alps and the Himalayas, which have been produced in quite late geological times. It is possible that this conclusion is in the main true; but in coming to this conclusion we must give due value to the number of patches which have been let into the old crustal envelope—masses of igneous rock, mineral veins and hydrated products which have been formed in areas of temporary stretching, and have remained as permanent additions to the crust, increasing the size and bagginess of the old coat, which, since the discovery of radium, is now regarded as much older than was formerly imagined by non-geological members of the scientific world.

The peculiar nature of rock-folds presents also an obstacle no less formidable from a qualitative point of view. If the skin were merely collapsing on its shrinking core we should expect wrinkles in all directions; yet we find great folded areas like the Himalayas stretching continuously for 1,400 miles, with signs of a persistently directed overthrust from the north; or we have folded masses like the Appalachians of a similar order of magnitude stretching from Maine to Georgia, with an unmistakable compression in a northwest to southeast direction. The simple hypothesis of a collapsing crust is thus "quantitatively insufficient," according to Dutton, though this is still doubtful, and it is "qualitatively inapplicable," which is highly probable.

In addition to the facts that rock-folds are maintained over such great distances and that later folds are sometimes found to be superimposed on older ones, geologists have to account for the conditions which permit of the gradual accumulation of enormous thicknesses of strata without corresponding rise of the surface of deposition.

On the other hand, too, in folded regions there are exposures of beds superimposed on one another with a total thickness of many miles more than the height of any known mountain, and one is driven again to conclude that uplift has proceeded *pari passu* with the removal of the load through the erosive work of atmospheric agents.

It does not necessarily follow that these two processes are the direct result of loading in one case and of relief in the other; for slow subsidence gives rise to the conditions that favor deposition and the uplifting of a range results in the increased energy of eroding streams.

Thus there was a natural desire to see if Dutton's theory agreed with the variations of gravity. If the ups and downs are bal-

anced, the apparently large mass of a mountain-range ought to be compensated by lightness of material in and below it. Dutton was aware of the fact that this was approximately true regarding the great continental plateaus and oceanic depressions; but he imagined that the balance was delicate enough to show up in a small hill-range of 3,000 to 5,000 feet.

The data required to test this theory, accumulated during the triangulation of the United States, have been made the subject of an elaborate analysis by J. F. Hayford and W. Bowie.[3] They find that, by adopting the hypothesis of isostatic compensation, the differences between the observed and computed deflections of the vertical caused by topographical inequalities are reduced to less than one tenth of the mean values which they would have if no isostatic compensation existed. According to the hypothesis adopted, the inequalities of gravity are assumed to die out at some uniform depth, called the depth of compensation, below the mean sea-level. The columns of crust material standing above this horizon vary in length according to the topography, being relatively long in highlands and relatively short under the ocean. The shorter columns are supposed to be composed of denser material, so that the product of the length of each column by its mean density would be the same for all places. It was found that, by adopting 122 kilometers as the depth of compensation, the deflection anomalies were most effectually eliminated, but there still remained unexplained residuals or local anomalies of gravity to be accounted for.

Mr. G. K. Gilbert,[4] who was one of the earliest geologists to turn to account Dutton's theory of isostasy, has recently offered a plausible theory to account for these residual discrepancies between the observed deflections and those computed on the assumption of isostatic compensation to a depth of 122 kilometers. An attempt had already been made by Hayford and Bowie to correlate the distribution of anomalies with the main features of the geological map and with local changes in load that have occurred during comparatively recent geological times. For example, they considered the possibility of an increased load in the lower Mississippi valley, where there has been in recent times a steady deposition of sediment, and therefore possibly the accumulation of mass slightly in advance of isostatic adjustment. One would expect in such a case that there would be locally shown a slight excess of gravity, but, on the contrary, there is a general prevalence of negative anomalies in this region. In the Appalachian region, on the other hand, where there has been during late geological times continuous erosion, with consequent unloading, one would expect that the gravity values would be lower, as isostatic compensation would naturally lag behind the loss of overburden; this, however, is also not the case, for over a greater part of the Appalachian region the anomalies are of the positive order. Similarly, in the north central region, where there has been since Pleistocene times a removal of a heavy ice-cap, there is still a general prevalence of positive anomalies.

These anomalies must, therefore, remain

[3] J. F. Hayford, "The Figure of the Earth and Isostasy," U. S. Coast and Geodetic Survey, Washington, 1909. "Supplementary Investigation," Washington, 1910. See also *Science*, New Series, Vol. XXXIII., p. 199, 1911. J. F. Hayford and W. Bowie, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," U. S. Coast and Geodetic Survey Special Publication No. 10, Washington, 1912.

[4] "Interpretation of Anomalies of Gravity," U. S. Geol. Surv. Professional Paper 85-C, 1913, p. 29.

unexplained by any of the obvious phenomena at the command of the geologist. G. K. Gilbert now suggests that, while it may be true that the product of the length of the unit column by its mean density may be the same, the density variations within the column may be such as to give rise to different effects on the pendulum. If, for instance, one considers two columns of the same size and of exactly the same weight, with, in one case, the heavy material at a high level and in the other case with the heavy material at a low level, the center of gravity of the former column, being nearer the surface, will manifest itself with a greater pull on the pendulum; these columns would be, however, in isostatic adjustment.[5]

Gilbert's hypothesis thus differs slightly from the conception put forth by Hayford and Bowie; for Gilbert assumes that there is still appreciable heterogeneity in the more deep-seated parts of the earth, while Hayford and Bowie's hypothesis assumes that in the nuclear mass density anomalies have practically disappeared, and that there is below the depth of compensation an adjustment such as would exist in a mass composed of homogeneous concentric shells.

In order to make the Indian observations comparable to those of the United States as a test of the theory of isostasy, Major H. L. Crosthwait[6] has adopted Hayford's system of computation and has applied it to 102 latitude stations and 18 longitude stations in India. He finds that the unexplained residuals in India are far more pronounced than they are in the United States, or, in other words, it would appear that isostatic conditions are much more nearly realized in America than in India.

The number of observations considered in India is still too small for the formation of a detailed map of anomalies, but the country can be divided into broad areas which show that the mean anomalies are comparable to those of the United States only over the Indian peninsula, which, being a mass of rock practically undisturbed since early geological times, may be regarded safely as having approached isostatic equilibrium. To the north of the peninsula three districts form a wide band stretching west-north-westwards from Calcutta, with mean residual anomalies of a positive kind, while to the north of this band lies the Himalayan belt, in which there is always a large negative residual.

Colonel Burrard[7] has considered the Himalayan and Sub-Himalayan anomalies in a special memoir, and comes to the conclusion that the gravity deficiency is altogether too great to be due to a simple geosynclinal depression filled with light alluvium such as we generally regard the Gangetic trough to be. He suggests that the rapid change

[5] It is interesting to note that the idea suggested by G. K. Gilbert in 1913 was partly anticipated by Major H. L. Crosthwait in 1912 (Survey of India, Professional Paper No. 13, p. 5). Major Crosthwait in discussing the similar gravity anomalies in India remarks parenthetically: "Assuming the doctrine of isostasy to hold, is it not possible that in any two columns of matter extending from the surface down to the depth of compensation there may be the same mass, and yet that the density may be very differently distributed in the two columns? These two columns, though in isostatic equilibrium, would act differently on the plumb-line owing to the unequal distribution of mass.

"The drawback to treating this subject by hard and fast mathematical formulæ is that we are introducing into a discussion of the constitution of the earth's crust a uniform method when, in reality, probably no uniformity exists."

[6] Survey of India, Professional Paper No. 13, 1912.

[7] Survey of India, Professional Paper No. 12, 1912.

in gravity values near the southern margin of the Himalayan mass can be explained only on the assumption of the existence of a deep and narrow rift in the sub-crust parallel to the general Himalayan axis of folding. A single large rift of the kind and size that Colonel Burrard postulates is a feature for which we have no exact parallel; but one must be careful not to be misled by the use of a term which, while conveying a definite mental impression to a mathematician, appears to be incongruous with our geological experience. There may be no such thing as a single large rift filled with light alluvial material, but it is possible that there may still be a series of deep-seated fissures that might afterwards become filled with mineral matter.

With this conception of a rift or a series of rifts, Colonel Burrard is led to reverse the ordinary mechanical conception of Himalayan folding. Instead now of looking upon the folds as due to an overthrust from the north, he regards the corrugations to be the result of an under-creep of the sub-crust towards the north. Thus, according to this view, the Himalaya, instead of being pushed over like a gigantic rock-wave breaking on to the Indian *Horst* is in reality being dragged away from the old peninsula, the depression between being filled up gradually by the Gangetic alluvium. So far as the purely stratigraphical features are concerned, the effect would be approximately the same whether there is a superficial overthrust of the covering strata or whether there is a deep-seated withdrawal of the basement which is well below the level of observation.

Since the Tibetan expedition of ten years ago we have been in possession of definite facts which show that to the north of the central crystalline axis of the Himalaya there lies a great basin of marine sediments forming a fairly complete record from Paleozoic to Tertiary times, representing the sediments which were laid down in the great central Eurasian ocean to which Suess gave the name *Tethys*. We have thus so far been regarding the central crystalline axis of the Himalaya as approximately coincident with the old northern coastline of Gondwanaland; but, if Colonel Burrard's ideas be correct, the coast line must have been very much further to the south before the Himalayan folding began.

Representing what the Geological Survey of India regards as the orthodox view, Mr. H. H. Hayden[8] has drawn attention to some conclusions which, from our present geological knowledge, appear to be strange and improbable in Colonel Burrard's conclusions, and he also offers alternative explanations for the admitted geodetic facts. Mr. Hayden suggests, for instance, that the depth of isostatic compensation may be quite different under the Himalayan belt from that under the regions to the south. His assumptions, however, in this respect are, as pointed out by Colonel G. P. Lenox Conyngham,[9] at variance with the whole theory of isostasy. Mr. Hayden then suggests that most of the excessive anomalies would disappear if we took into account the low specific gravity of the Sub-Himalayan sands and gravels of Upper Tertiary age as well as of the Pleistocene and recent accumulations of similar material filling the Indo-Gangetic depression. It would not be at all inconsistent with our ideas derived from geology to regard the Gangetic trough as some three or four miles deep near its northern margin, thinning out gradually towards the undisturbed mass of the Indian peninsula, and Mr. R. D. Oldham,[10]

[8] *Rec. Geol. Surv. Ind.*, Vol. XLIII., Part 2, p. 138, 1913.

[9] *Records of the Survey of India*, Vol. V., p. 1.

[10] *Proc. Roy. Soc.*, Series A, Vol. 90, p. 32, 1914.

with this view, has also calculated the effect of such a wedge of alluvial material of low specific gravity, coming to the conclusion that the rapid change in deflection, on passing from the Lower Himalaya southward towards the peninsula, can mainly be explained by the deficiency of mass in the alluvium itself.

It is obvious that, before seeking for any unusual cause for the gravity anomalies, we ought to take into account the effect of this large body of alluvium which lies along the southern foot of the range. It is, however, by no means certain that a thick mass of alluvial material, accumulated slowly and saturated with water largely charged with carbonate of lime, would have a specific gravity so appreciably lower than that of the rocks now exposed in the main mass of the Himalaya as to account for the residual anomalies. Some of the apparent deficiency in gravity is due to this body of alluvium, but it will only be after critical examination of the data and more precise computation that we shall be in a position to say if there is still room to entertain Colonel Burrard's very interesting hypothesis.

By bringing together the geological and geodetic results we notice five roughly parallel bands stretching across northern India. There is (1) a band of abnormal high gravity lying about 150 miles from the foot of the mountains, detected by the plumb-line and pendulum; (2) the great depression filled by the Gangetic alluvium; (3) the continuous band of Tertiary rock, forming the Sub-Himalaya, and separated by a great boundary overthrust from (4) the main mass of the Outer and Central Himalaya of old unfossiliferous rock, with the snow-covered crystalline peaks flanked on the north by the (5) the Tibetan basin of highly fossiliferous rocks formed in the great Eurasian Mediterranean ocean that persisted up to nearly the end of Mesozoic times.

That these leading features in North India can hardly be without genetic relationship one to another is indicated by the geological history of the area. Till nearly the end of the Mesozoic era the line of crystalline, snow-covered peaks now forming the Central Himalaya was not far from the shore-line between Gondwanaland, stretching away to the south, and Tethys, the great Eurasian ocean. Near the end of Mesozoic times there commenced the great outwelling of the Deccan Trap, the remains of which, after geological ages of erosion, still cover an area of 200,000 square miles, with a thickness in places of nearly 5,000 feet. Immediately after the outflow of this body of basic lava, greater in mass than any known eruption of the kind, the ocean flowed into Northwest India and projected an arm eastwards to a little beyond the point at which the Ganges now emerges from the hills. Then followed the folding movements that culminated in the present Himalayan range, the elevation developing first on the Bengal side, and extending rapidly to the northwest until the folds extended in a great arc for some 1,400 miles from southeast to northwest.

New streams developed on the southern face of the now rising mass, and although the arm of the sea that existed in early Tertiary times became choked with silt, the process of subsidence continued, and the gradually subsiding depression at the foot of the hills as fast as it developed became filled with silt, sand, gravel and boulders in increasing quantities as the hills became mountains and the range finally reached its present dimensions, surpassing in size all other features of the kind on the face of the globe.

Now, it is important to remember that for ages before the great outburst of Dec-

can Trap occurred there was a continual unloading of Gondwanaland, and a continual consequent overloading of the ocean bed immediately to the north; that this process went on with a gradual rise on one side and a gradual depression on the other; and that somewhere near and parallel to the boundary line the crust must have been undergoing stresses which resulted in strain, and, as I suggest, the development of those fissures that let loose the floods of Deccan Trap and brought to an end the delicate isostatic balance.

During the secular subsidence of the northern shore line of Gondwanaland, accompanied by the slow accumulation of sediment near the shore and the gradual filing away of the land above sea-level, there must have been a gradual creep of the crust in a northerly direction. Near the west end of the Himalayan arc this movement would be towards the northwest for a part of the time; at the east end the creep would be towards the north-northeast and northeast. Thus there would be a tendency from well back in Paleozoic times up to the end of the Cretaceous period for normal faults—faults of tension—to develop on the land, with a trend varying from W.S.W.-E.N.E. to W.N.W.-E.S.E. across the northern part of Gondwanaland. We know nothing of the evidence now pigeon-holed below the great mantle of Gangetic alluvium, while the records of the Himalayan region have been masked or destroyed by later foldings. But in the stratified rocks lying just south of the southern margin of the great alluvial belt we find a common tendency for faults to strike in this way across the present peninsula of India. These faults have, for instance, marked out the great belt of coal-fields stretching for some 200 miles from east to west in the Damuda valley. On this, the east side of India, the fractures of tension have a general trend of W.N.W.-E.S.E. We know that these faults are later than the Permian period, but some of them certainly were not much later.

If now we go westwards across the Central Provinces and Central India and into the eastern part of the Bombay Presidency, we find records of this kind still more strikingly preserved; for where the Gondwana rocks, ranging from Permo-Carboniferous to Liassic in age, rest on the much older Vindhyan series, we find three main series of these faults. One series was developed before Permo-Carboniferous times; another traverses the lower Gondwanas, which range up to about the end of Permian times; while the third set affects the younger and Upper Gondwanas of about Rhætic or Liassic age. Although the present topography of the country follows closely the outlines of the geological formations, it is clear from the work of the Geological Survey of India that these outlines were determined in Mesozoic times, and that the movements which formed the latest series of faults were but continuations of those which manifested themselves in Paleozoic times. According to Mr. J. G. Medlicott, the field data showed "that a tendency to yield in general east and west or more clearly northeast and southwest lines existed in this great area from the remote period of the Vindhyan fault."[11] The author of the memoir and map on this area was certainly not suspicious of the ideas of which I am now unburdening my mind; on the contrary, he attempted and, with apologies, failed to reconcile his facts to views then being pushed by the weight of "authority" in Europe. This was not the last time that facts established in India were found (to use a field-geologist's term) unconformably to lie on a basement of

[11] *Mem. Geol. Surv. Ind.*, Vol. II., 1860, Part 2, p. 256.

geological orthodoxy as determined by authority in Europe. It is important to notice that the series of faults referred to in the central parts of India are not mere local dislocations, but have a general trend for more than 250 miles.

A fault must be younger, naturally, than the strata which it traverses, but how much younger can seldom be determined. Intrusive rocks of known age are thus often more useful in indicating the age of the fissures through which they have been injected, and consequently the dykes which were formed at the time of the eruption of the great Deccan Trap give another clue to the direction of stresses at this critical time, that is towards the end of the Cretaceous period, when the northerly creep had reached its maximum, just before Gondwanaland was broken up. If, now, we turn to the geological maps of the northern part of Central India, the Central Provinces, and Bengal, we find that the old Vindhyan rocks of the Narbada valley were injected with hundreds of trap-dykes which show a general W.S.W.–E.N.E. trend, and thus parallel to the normal tension faults, which we know were formed during the periods preceding the outburst of the Deccan Trap. This general trend of faults and basic dykes is indicated on many of the published geological maps of India covering the northern part of the peninsula, including Ball's maps of the Ramgarh and Bokaro coalfields[12] and of the Hutar coalfield,[13] Hughes's Rewa Gondwana basin,[14] Jones's southern coalfields of the Satpura basin,[15] and Oldham's general map of the Son valley.[16]

We see, then, that the development of fissures with a general east-west trend in the northern part of Gondwanaland culminated at the end of the Cretaceous period, when they extended down, probably, to the basic magma lying below the crust either in a molten state, or in a state that would result in fluxion on the relief of pressure. That the molten material came to the surface in a superheated and liquid condition is shown by the way in which it has spread out in horizontal sheets over such enormous areas. Throughout this great expanse of lava there are no certain signs of volcanic centers, no conical slopes around volcanic necks; and one might travel for more than 400 miles from Poona to Nagpur over sheets of lava which are still practically horizontal. There is nothing exactly like this to be seen elsewhere to-day. The nearest approach to it is among the Hawaiian calderas, where the highly mobile basic lavas also show the characters of superfusion, glowing, according to J. D. Dana,[17] with a white heat, that is, at a temperature not less than about 1,300° C.

Mellard Reade has pointed out that the earth's crust is under conditions of stress analogous to those of a bent beam, with, at a certain depth, a "level of no strain." Above this level there should be a shell of compression, and under it a thicker shell of tension. The idea has been treated mathematically by C. Davison, G. H. Darwin, O. Fisher, and M. P. Rudski, and need not be discussed at present. Professor R. A. Daly has taken advantage of this view concerning the distribution of stresses in the crust to explain the facility for the injection of dykes and batholiths from the liquid, or potentially liquid, gabbroid magma below into the shell of tension.[18] He also shows

12 *Ibid.*, Vol. VI., Part 2.

13 *Ibid.*, Vol. XV.

14 *Ibid.*, Vol. XXI., Part 3.

15 *Ibid.*, Vol. XXIV.

16 *Ibid.*, Vol. XXXI., Part 1.

17 "Characteristics of Volcanoes," 1891, p. 200.

18 R. A. Daly, "Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain-building," *Amer. Jour. Sci.*, XXII., September, 1906, p. 205.

that the injection of large bodies of basic material into the shell of tension tends on purely mechanical grounds to the formation of a depression, or geosyncline. If this be so, are we justified in assuming that the heavy band following the southern margin of the Gangetic geosyncline is a "range" of such batholiths? The idea is not entirely new; for O. Fisher made the suggestion more than twenty years ago that the abnormal gravity at Kalianpur was due to "some peculiar influence (perhaps of a volcanic neck of basalt)."[19]

Daly's suggestion, however, taken into account with the history of Gondwanaland, may explain the peculiar alignment of the heavy subterranean band, parallel to the Gangetic depression and parallel to the general trend of the peninsular tension-faults and fissures that followed the unloading of Gondwanaland and the heavy loading of the adjoining ocean bed along a band roughly parallel to the present Himalayan folds.

R. S. Woodward objected that isostasy does not seem to meet the requirements of geological continuity, for it tends rapidly towards stable equilibrium, and the crust ought therefore to reach a stage of repose early in geologic time.[20] If the process of denudation and rise, with adjoining deposition and subsidence, occurred on a solid globe, this objection might hold good. But it seems to me that the break-up of Gondwanaland and the tectonic revolutions that followed show how isostasy can defeat itself in the presence of a sub-crustal magma actually molten or ready to liquefy on local relief of pressure. It is possible that the protracted filing off of Gondwanaland brought nearer the surface what was once the local level of no-strain and its accompanying shell of tension.

The conditions existing in northern Gondwanaland before late Mesozoic times must have been similar to those in southwest Scotland before the occurrence of the Tertiary eruptions, for the crust in this region was also torn by stresses in the S.W.–N.E. direction with the formation of a remarkable series of N.W.–S.E. dykes which give the one-inch geological maps in this region a regularly striped appearance.

There is no section of the earth's surface which one can point to as being now subjected to exactly the same kind and magnitude of treatment as that to which Gondwanaland was exposed for long ages before the outburst of the Deccan Trap; but possibly the erosion of the Brazilian highlands and the deposition of the silt carried down by the Amazon, with its southern tributaries, and by the more eastern Araguay and Tocantins, may result in similar stresses which, if continued, will develop strains, and open the way for the subjacent magma to approach the surface or even to become extravasated, adding another to the small family of so-called fissure-eruptions.

The value of a generalization can be tested best by its reliability as a basis for prediction. Nothing shows up the shortcomings of our knowledge about the state of affairs below the superficial crust so effectually as our inability to make any useful predictions about earthquakes or volcanic eruptions. For many years to come in this department of science the only worker who will ever establish a claim to be called a prophet will be one in Cicero's sense—"he who guesses well."

Thomas H. Holland

[19] "Physics of the Earth's Crust," 2d ed., 1889, p. 216.

[20] "Address to the Sect. of Mathematics and Astronomy of the Amer. Assoc.," 1889, *Smithsonian Report*, 1890, p. 196.

FRATERNITIES AND SCHOLARSHIPS AT THE UNIVERSITY OF ILLINOIS

For the past five years the office of the Dean of Men of the University of Illinois has been keeping records of the scholarship averages of the chapters of national social fraternities represented in the university. For the first two years these averages were not published. In 1912 the figures were given to the *Alumni Quarterly* with the idea that their publication might be of interest to fraternity alumni. Immediately the active members of the fraternities became interested in the scholarship ranking, and the next report was published in the *Daily Illini*. Now the semi-annual publication of the averages is awaited with no little impatience by the fraternities; in fact, from the time of the semester examinations to the publication of the report, the office of the dean of men is crowded with inquiries concerning the progress of the report.

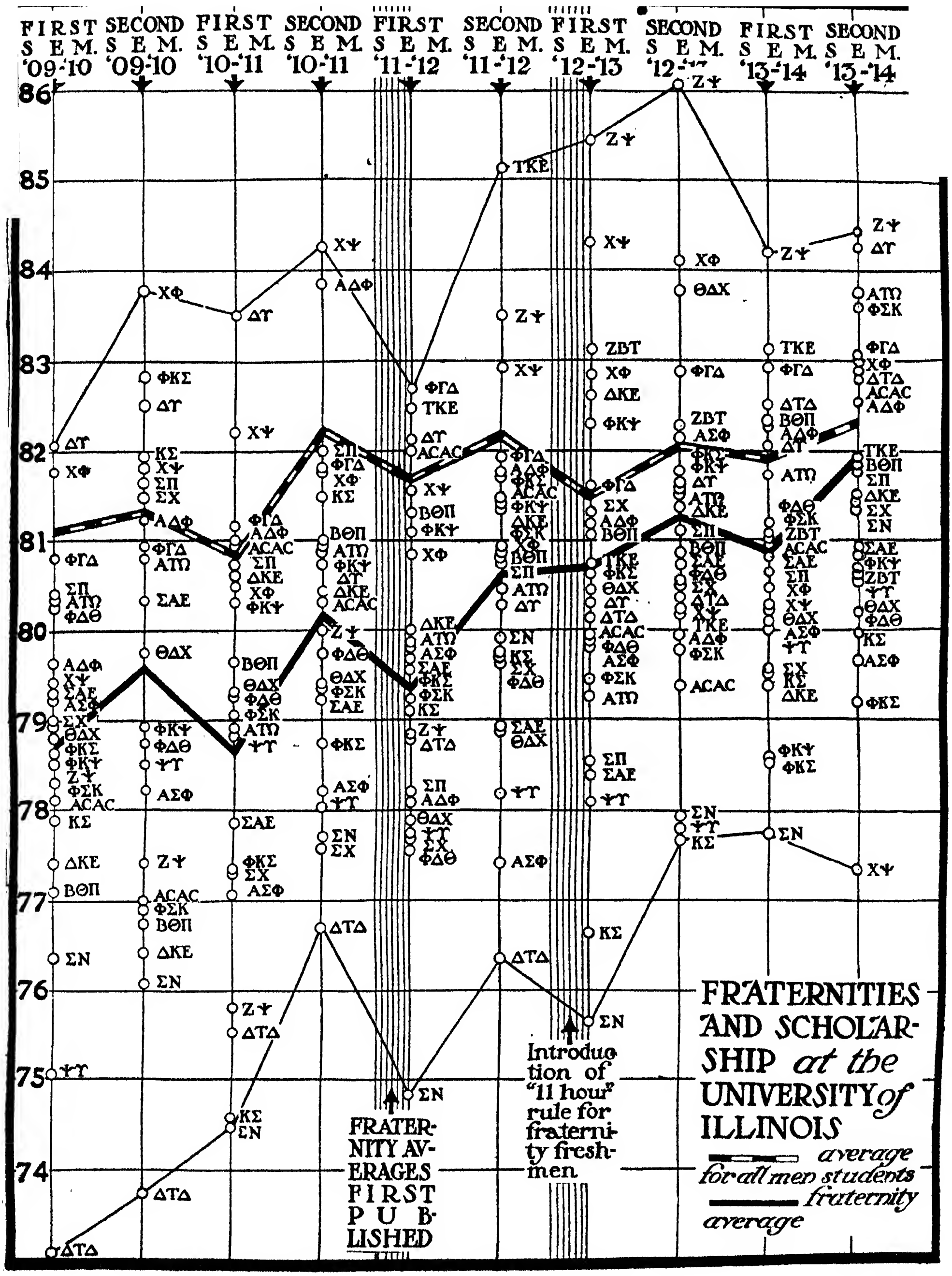
The accompanying graph has been prepared from the scholarship averages in the university for the ten semesters beginning with the first semester of 1909–1910. It shows specifically a comparison of the general fraternity average with the general university average for men; the effect upon the fraternity average of the publication of scholarship rankings and of the university regulation which provides that freshmen must obtain eleven hours of university credit before they may be initiated into a fraternity; and a study of the ups and downs of the averages of certain chapters. The graph is based upon the averages of 700 fraternity men and 2,600 fraternity and non-fraternity men.

A glance at the graph will show that in the ten semesters the fraternity average has gained upon the general university average for men, although it is still a little below it. Also, in 1909 the chapters were widely scattered up and down the scale, and in 1914 they are closely grouped around the fraternity average. This fact means undoubtedly that during the interval between these years the fraternities have intensified their attention to scholarship; the various chapters are so much alike generally that when they all enter upon the same purpose they are likely to end up closely grouped.

At two points the fraternity average jumps up quite suddenly. One point is the second semester after the introduction of the practise of publishing the averages, and the other is the semester in which was introduced the regulation controlling the initiation of freshmen. The experience of the office of dean of men, as well as the graph, records that with the publication of the averages for the first time there came a quite sudden awakening of the fraternities to scholarship matters. The office at that time was forced to provide a special system for satisfying the demands of fraternity officers for periodical reports on the progress of the members.

The reasons why the fraternities reacted so strongly to this stimulus for higher averages are various. The chapters at the bottom have undoubtedly been literally shamed into trying to raise their rating. A member of one of the chapters near the bottom when the first report was published said to me, "For years we have listened to lectures on scholarship from national officers and alumni, but nothing ever waked us up like that report. Why, everywhere we went we were 'kidded' and laughed at until, at last, in sheer desperation we took to studying." The fraternities near the top have been spurred on, undoubtedly, by the very natural desire to be first. But the great majority of the chapters are in little danger of being last and in only a small probability of being first. These middle-rank chapters, however, show fully as much concern over holding their position or improving it as do the chapters at the top and the bottom.

The reasonable explanation is, I think, that the acknowledged rivalry which has long existed in certain groups of fraternities has come to include scholarship. The fraternities may not have welcomed scholarship as a standard of comparison, but since the condition has been forced on them they are making the most of it. A member of one chapter said to me recently, "As soon as these averages are published the so-and-so chapter send in to their national officers both their average and ours." These two fraternities are strong rivals nationally. Another man said, in speaking of a freshman rushee from a small town,


FIRST SEM. '09-'10
SECOND SEM. '09-'10
FIRST SEM. '10-'11
SECOND SEM. '10-'11
FIRST SEM. '11-'12
SECOND SEM. '11-'12
FIRST SEM. '12-'13
SECOND SEM. '12-'13
FIRST SEM. '13-'14
SECOND SEM. '13-'14
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FRATERNITY AVERAGES FIRST PUBLISHED
Introduction of "11 hour" rule for fraternity freshmen
FRATERNITIES AND SCHOLARSHIP at the UNIVERSITY of ILLINOIS
average for all men students
fraternity average

"He didn't know a thing about national standing, but he knew exactly the scholastic reputation of every bunch which he was considering." I do not suppose that good or bad scholarship in the abstract, unless it is very good or bad, enters largely into the reputation of a chapter, but the fact that in the only definite scheme of ranking we have this or that chapter ranks high or low is taken as a presumption of its general merit.

A rather interesting commentary on the prevailing attitude toward low averages is an ironical line which appeared in the funny column of the *Daily Illini*, apropos of the return in the second semester of certain well-known fraternity men who had been dropped out a semester for poor scholarship: "Now listen to the joyous celebration in the fraternities upon the return of some exiled flunker, batting average 52.08."

Beginning with the first semester of 1912–1913 the university at the request of the fraternities put into effect a rule providing that no freshman could be initiated into a fraternity until he had earned eleven hours of university credits. The immediate effect of this rule, as shown by the graph, was to give the general fraternity average a gain of one point over the general university average. (The actual gain of the fraternity average over the non-fraternity average was more, for the general university average includes the fraternity average.)

The direct benefit of this rule is, of course, upon the freshmen. The effect, however, has been felt by the fraternities all through, due, perhaps, to the additional emphasis placed upon scholarship in fraternity welfare, and especially upon the need which the fraternities have found to make conditions for study as favorable as possible for the freshmen. The flunking freshman has long been the "gold brick" which every fraternity might buy unwittingly. The erratic record of Kappa Sigma in 1909 and 1910, as shown by the graph, as well as the record of Sigma Nu in 1910–1911, is explained by the coming in and the going out of the freshman flunker. In these cases the average for the first semester is very low; in the second semester, after the freshman flunkers have dropped out, the average unexpectedly climbs.

The rushing season at the university is very short and hurried, and only the most exceptional care serves to guard the fraternities against the irresponsible and purposeless freshman who will turn out to be a loafer unless he finds a strong necessity to be otherwise. There are always many such freshmen who must in one way or another be held to study during that early period which comes before they have learned the need and value of study for study's sake. This freshman rule furnishes to fraternity freshmen the necessity and incentive to do otherwise than loaf.

The following table shows the effect of this rule upon fraternity freshmen:

Average of fraternity freshmen 1st semester, 1910–11	80.57
Average of fraternity freshmen 1st semester, 1913–14	82.29

During the present year the fraternity freshman has been in an enviable place so far as grades are concerned, for he ranks higher than non-fraternity freshmen, higher than fraternity upperclassmen, and higher than the general university average for men, as follows:

Average of fraternity freshmen 1st semester 1913–14	82.29
Average of non-fraternity freshmen 1st semester 1913–14	81.19
Average of fraternity upperclassmen 1st semester 1913–14	80.32
General University average for men 1st semester 1913–14	81.95

The ambition of the freshman to pass eleven hours so that he may be initiated is, of course, not alone responsible for this high average of fraternity freshmen. It is to the interest of the chapter and its reputation to initiate all of its pledges; and so most of the chapters have strict rules for the conduct of the freshmen during study hours and in other ways urge them to study. I think, however, that the prospect of initiation at the end of the first semester furnishes a stronger stimulus than would the prospect of initiation at the end of a year's work. One is led to the conclusion that if the upperclassmen were as closely supervised as

the freshmen are the fraternity average would probably creep up a notch or two farther. But as it is, the gain for the upperclassman is considerable, for a good start in the freshman year is likely to stand him in good stead for the three years thereafter. For this reason the fraternity average ought to show the effect of the introduction of this rule by a rise for the next two years, or during the period while the first two classes to enter under the rule are becoming juniors and seniors.

An interesting sidelight on the new state of affairs is the fact that at the end of the first semester of 1913–1914 five freshmen were released from their pledges to fraternities mainly because they had turned out to be hopelessly poor students.

The gain shown in the fraternity average as a result of the working of these two factors is gratifying. It is, however, perhaps too much to expect that the gap between the two averages will be closed up entirely. The normal position in most universities for the fraternity average is slightly below the general average. The explanation usually given for this condition is that the fraternities harbor the lowest average men in the university, and are thereby handicapped. Even the average fraternity men will advance this explanation. The following table, based on grades made in the first semester of 1913–1914, however, seems to indicate that such explanation is not the true one:

TABLE TO SHOW A COMPARISON OF GRADES WITHIN SPECIFIED LIMITS

	Non-fraternity Averages, Per Cent.	Fraternity Averages, Per Cent.
90–100	9	7
80– 90	58	54
70– 80	27	34
0– 70	6	5

This comparison shows that although there is a larger percentage of non-fraternity averages above 90 than fraternity averages, there is also a slightly larger percentage below passing. Apparently, then, the high and low average men are not responsible for the difference in the general averages. The middle average men seem to have the responsibility instead. Fraternity men seem more likely to be content with grades between 70 and 80 than do non-fraternity men.

It is perhaps true that in certain chapters two or three very low men are to blame for dragging down the chapter's average, but it would seem to be true that the general fraternity average is dragged down by the men who could do 85 per cent. work, but are content to do 80 per cent. or 75 per cent. work. Fraternity men are more generally represented in outside activities than non-fraternity men and it is barely possible that this fact explains their lower average. But it has been the experience of this office that the men who are active within reasonable limits in outside activities are usually pretty good students. The loafer in the classroom is usually a loafer outside. Another explanation, which I think is somewhere near the true one, is that among fraternity men the desire for high grades usually gives way to a feeling of satisfaction with passing grades. Other rewards, not open to non-fraternity men, come to take the place of the delight in high grade work which very often is the most satisfying delight of the non-fraternity man's college life.

A vast amount of chapter history is involved in the record of the ups and downs of the various averages. Chapter conditions will almost always account for the variations from year to year. Any sudden rise or fall in any chapter's record can usually be accounted for by the character of the men who were in control in the chapter at the time. For instance the sudden decline of Delta Upsilon in 1912 can be explained by an examination of the upperclassmen at that time. The quite phenomenal rise and fall of Theta Delta Chi in 1913 is explained by the coming and going of a particularly forceful man in the chapter during the year. In most cases high averages or low averages are not dependent so much upon the presence in the chapter of a number of exceptionally high or low grade men as upon the presence or absence of a masterful leader.

The curve of the average of Zeta Psi is interesting. For five semesters it is very

low; then in one semester it takes a sudden rise, and in the next semester assumes the top place, where it remains for a quite long period. The impetus to scholarship in this chapter was furnished by the planning and activity of one man during the years 1910–1911 and 1911–1912. He worked out an efficient system for improving the scholarship of the active members of the chapters and insisted upon a careful selection of freshmen pledges. He was a determined, energetic type of man and completely and thoroughly ruled his chapter. The impetus which he had given the chapter when he graduated in 1912 enabled it to hold a high position for the four semesters succeeding. He successfully solved one of the two problems of fraternity scholarship, the problem of bringing up the average from a very low to a high place.

The other problem, that of holding the average to a high standard, seems to have been successfully solved by Phi Gamma Delta. During the ten semesters this chapter has held to a consistently high average, always holding one of the first seven places among the fraternities. In this case chapter traditions have played an important part. The reputation of the Phi Gams as good students was generally known; both faculty and students expected any and every member of the chapter to be a "shark." Working with this tradition it was not especially difficult for the strong upperclassmen to start the freshmen and sophomores on the high road. Only occasionally was hard driving necessary; the most effective factor was the good-natured, "everybody-get-into-the-game" attitude which all of the members seemed to have. This chapter has usually had one or two of their faculty members living in the house with the active members.

The sudden rise of Delta Tau Delta in 1913–1914, after this chapter had trailed most of the others for many semesters, was the result of cyclonic, plunging campaign, in which national officers, faculty members, alumni, as well as every active member, had an energetic part. A dean in the faculty, coming upon the scene at a ripe moment, entered into the spirit of the fight and lent his wise advice, a junior was appointed to be a sort of bookkeeper, whose duty it was to keep account of all of the absences taken by the members and to record all of the scholarship reports forwarded; and a senior, a forceful, impulsive football player, forced the fighting. The interesting fact is that this high rank was attained by almost exactly the same type of men who for years had been holding the average down. An alumnus of the chapter stated to me that the reason for their improvement was that the chapter was lucky in getting rid of its flunkers, but I was able to point out to him in the present chapter men who under the old conditions would have become the laziest of flunkers, filling in the places left by the outgoing loafers. The improvement in scholarship in this chapter was not primarily due to any careful selection of members; it was due almost entirely to a change of conditions and management within the chapter. I think the experience of Delta Tau Delta offers the most helpful suggestions to chapter officers who have an ambition to seek higher standards of scholarship.

Cyclonic campaigns of this kind, however, solve only one of the problems to be met by fraternity officers; it is even more difficult to keep the average consistently high than it is to raise it for a semester or two. The graph will show that many of the local chapters do their work by spurts, apparently lacking the ability to keep to any consistent high average. This is so certain that it is not especially difficult to read the signs in any specified chapter and predict that it will go up or down at the next change.

From my observations of the experience of fraternities in matters of scholarship I have concluded that the one factor which stands out above others as being valuable and important is chapter management. A brief comparison of four fraternities, Phi Gamma Delta, Alpha Tau Omega, Sigma Chi and Delta Tau Delta, points to this conclusion rather clearly. These four chapters have been in existence in the university longer than most of the others, and they are remarkably alike in many respects. The chapter living conditions are much the same; each owns a comfortable house of about the same valuation; the expenses of the mem-

bers are very likely about the same in each case. Their faculty and alumni connections are similar; their college activity has been about equal. Their members are drawn from about the same localities, that is, the majority of their members come from down state communities. If the freshmen pledged to these four chapters were lined up it would be highly difficult to point out to which chapter the different men were pledged. But in matters of scholarship there have been many big differences during the ten semesters. The reason for these differences is without doubt in the difference in chapter management. Only in this way could one explain why freshmen so much alike on entering should make up chapters so different in scholarship.

A member of Sigma Chi contends that their greatest handicap has been in the weakness of the junior and senior classes year in and year out. A comparison of these four chapters on this point shows the following results:

	Number Initiated in Ten Semesters	Number Graduated in Ten Semesters
Phi Gamma Delta ...	53	32
Alpha Tau Omega ...	55	29
Sigma Chi	59	20
Delta Tau Delta	61	16

In a chapter where the upper classes are weak the work is doubled; more freshmen must be initiated and trained to fill up the gaps, and at the same time there are fewer upperclassmen available for developing the underclassmen and for furnishing efficient leadership. Then, too, the presence around the house of a number of men who expect to drop out at the end of the semester without trying to complete their courses is very demoralizing upon the work of all other members of the chapter. I have no doubt that many chapters could strengthen themselves very greatly by building up a tradition that the members of the chapter should feel an obligation to stay in college until graduation.

Another conclusion that must inevitably be drawn is that the fraternity upperclassmen are open to a charge that fraternity life engenders in the members a spirit of contentment with a grade of work somewhat lower than that of which the men are capable. The freshmen seem to be holding up their end pretty well; but the upperclassmen fail to live up to the promises of the freshmen year. This charge is really serious, and the fraternities will have to meet it sooner or later. State universities are too expensively equipped to allow any of the students to do less than their best without damaging the interests of the citizens of the state. These universities, too, are so peculiarly prepared to give a kind of training that the students may get nowhere else that fraternity men may not say that they are justified in sacrificing a part of the benefit of this training in order to get other kinds of training which, in most cases, can be obtained elsewhere. By bringing their average up to that of the general university average for men the fraternities may show that they are not guilty of the charge that they tend to develop a happy mediocrity in their members toward matters of scholarship.

ARTHUR RAY WARNOCK
UNIVERSITY OF ILLINOIS

THEODORE NICHOLAS GILL

MANY scientific associates and friends of Dr. Theodore Nicholas Gill, who died in Washington City at noon on September 25, 1914, met on the following day at the U. S. National Museum to do honor to the memory of their deceased colleague. Among those who spoke were Dr. Richard Rathbun, Acting Secretary of the Smithsonian Institution, Mr. Leonhard Stejneger, Dr. L. O. Howard, Dr. Paul Bartsch, Dr. Frank Baker, and Mr. Paul Brockett of the Museum staff, as well as Dr. Hugh M. Smith, Commissioner of Fisheries. A tribute expressing the sorrow attendant on his death and the great loss to science in general and the Smithsonian Institution and National Museum in particular was adopted at the meeting.

Dr. Theodore Gill, as he was best known, was the son of James Darrell and Elizabeth Vosburgh Gill, and was born in New York City on March 21, 1837. His early education

was received in private schools and from special tutors, and then he studied law, but was never admitted to the bar. As he grew to manhood he developed an interest in natural science and became especially interested in fishes, frequently visiting the markets along the river fronts in New York for the purpose of examining the uncommon varieties that were received there. During the winter of 1857–58 he visited Barbados, Trinidad and other West Indian Islands for Mr. D. Jackson Stewart, for whom he collected shells and various specimens of natural history. The results of his explorations were worked up mainly in the library of Mr. J. Carson Brevoort, and published in the *Annals* of the New York Lyceum of Natural History and in the *Proceedings* of the Philadelphia Academy of Natural Sciences. It was in this library (the best of its kind in the United States at that time) of this patron of science that he laid the foundations for that great knowledge of books and authorities which, combined with a splendid memory, served him so well in his after years. In 1859 he visited Newfoundland and studied its fauna, and in 1860 prepared a report on the fishes of the northern boundary for the State Department of the United States.

In 1861 he came to Washington and was given the teaching of zoology at Columbian, now George Washington, University, with which institution he remained connected until his death, although subsequent to 1910 he was emeritus professor of zoology. For much of the time during this long period he met his classes regularly, considering it a privilege to contribute his services to the university without compensation. Even after his retirement he continued his active interest in the department which he had organized and freely contributed aid and advice on all matters, devoting special attention, however, to the postgraduate work.

Almost immediately after settling in Washington, Gill came under the influence of Professor Spencer F. Baird, who was quick to appreciate his ability, and who found congenial work for him in the library of the Smithsonian Institution, of which he had charge from 1862 until 1866. When the library was transferred to the National collections in the Capitol he continued in that service until 1874 and was for a time assistant librarian of the Library of Congress. He then severed his connection with the library and thereafter devoted his attention almost exclusively to studies in natural history, working largely in the libraries of the Smithsonian Institution and the U. S. National Museum, holding the honorable appointment of associate in zoology on the scientific staff of the museum subsequent to 1894.

His activity as a zoologist was unceasing and his contribution to science included over five hundred separate papers, the greatest number of which have been on ichthyology. Of these many appear in the *Proceedings* of the Philadelphia Academy of Natural Sciences, but since 1878 the *Proceedings* of the U. S. National Museum have been his favorite medium of publication. His work was chiefly on systematic ichthyology, especially in the arrangement of fishes in classes, orders and families, yielding a more natural and restricted distribution of genera which is now universally accepted in the United States, and largely so in Europe. While no monumental work is left to us from his pen, nevertheless in nearly every zoological work his name will be found in connection with the descriptions, nomenclature, or classification of the specimens under discussion. Among the more important monographs prepared by him are the following: "Synopsis of Fresh-water Fishes" (1861); "Arrangement of the Families of Mollusks" (1871); "Arrangement of the Families of Mammals" (1872); "Arrangement of the Families of Fishes" (1872); "Catalogue of the Fishes of the East Coast of North America" (1861–73); "Principles of Zoogeography" (1884); "Scientific and Popular Views of Nature Contrasted;" "Account of Progress in Zoology" (1879–84); "Parental Care among Fresh-water Fishes" (1906); "Contributions to the Life-histories of Fishes" (1909). He wrote most of the volume on fishes and much of that on mammals in the "Standard Natural History" and was the author of numerous addresses and reviews that appeared in *Nature*, Science and other scien-

tific journals. The zoological portion of Johnson's Universal Cyclopædia and the zoological text of the Century and Standard Dictionaries were also prepared by him.

George Washington University recognized his splendid services so freely given to that institution by the conferment of the honorary degrees of A.M. in 1865; M.D. in 1866; Ph.D. in 1870, and finally in 1895 bestowing upon him its highest doctorate, that of laws. His many contributions to science were gladly recognized by honorary elections to more than seventy-five scientific societies. In the United States he was a member of the American Academy of Arts and Sciences, the American Philosophical Society, and the National Academy of Sciences. To the last of these he was elected in 1873, and at the time of his death his length of membership was exceeded by only five other members. He represented the academy at the International Zoological Congress in 1898 and was its delegate and that of the Smithsonian Institution at the 450th anniversary of the founding of the University of Glasgow in 1901. In 1868 he was elected to the American Association for the Advancement of Science, and in 1897 succeeded to the presidency of that organization on the death of his friend and colleague, Edward D. Cope.

It has been said that literature and science are not two things, but rather two aspects of the same thing—they both deal with knowledge, but the recorder of literature, the librarian, deals with knowledge in its secondary form, conclusions, which he files and reissues from time to time, while the scientist perhaps comes happily closer to nature itself through his personal investigations, the results of which he turns over to the recorder. Dr. Gill, it may be said, therefore possessed a remarkable dual ability, being both a librarian and a scientist, and, ably combining his talents, he made researches, recorded them and was able whenever called upon to present the results.

Having thus two distinct specialties, it may be readily understood that Dr. Gill, unlike many of our leading scholars, was not narrowed by a sole point of view, but possessed an exceptionally broad and generous mind, which he readily lent to divers purposes for the advancement and diffusion of scientific learning.

To establish a touch of fellowship and fraternalism among the men of the District of Columbia who had common interests in science, literature and the fine arts, he rendered much assistance during the organization of Washington's unique club, The Cosmos, and was enrolled as one of the ten founders who incorporated December 13, 1878. As a token of the esteem and affection with which he was held by the many members thereof, he was given a banquet by more than a hundred members of the club, on the occasion of his 75th birthday, and the 56th year of his published contributions to knowledge. This dinner was held on December 13, 1912, and was made the occasion for many valuable testimonials by some of the most learned scientific investigators and writers as well as numerous intimate friends, to his long and faithful services to science and literature.

As mentioned above, Dr. Gill did not incorporate his matchless store of knowledge in ponderous volumes of monumental dimensions, but as one of the speakers at the memorial meeting happily put it: "If you ask for his monument look around" in the minds and hearts of the scientific men who came into contact with him. To them he was an inexhaustible fountain both of inspiration and of information. Many a learned dissertation, many a brilliant combination or hypothesis, many a lucid and critical exposition, emanating from Washington biologists in almost every branch of the science, originated from discussions with Dr. Gill. They were in the habit of coming to him with their problems and their doubts and they seldom left him without receiving both ideas and information, no matter what their specialty. His mind was a wonderful combination of characteristics rarely found together in one man. A keenly critical and analytical power was paired with an unusually fine synthetic tact, and an amazing memory of details combined with a discriminating faculty of seeing essentials. He also possessed the fortunate gift of divesting himself of preconceived notions. Finally, no selfish desire for

self-aggrandizement obscured his judgment, which was guided solely by his desire for scientific honesty and truth. Small wonder that he became a progressive and a radical in systematic zoology, so much so that when he first published his classificatory arrangement of fishes and other vertebrates he was almost a generation ahead of his time. True, his ideas were taken up and carried out by his pupils, the American ichthyologists with David Starr Jordan at their head, but it is only recently that he had the satisfaction of learning that the European fish specialists have finally accepted his views, giving him unstinted praise for their originality and intrinsic worth.

SCIENTIFIC NOTES AND NEWS

M. Paul de Saint Marceaux has completed the monument which is to be dedicated in memory of Pierre Berthelot, the great French chemist, in front of the Collège de France, Paris.

On the occasion of the Australian meeting of the British Association, the University of Adelaide conferred the degree of doctor of science on Professor W. J. Sollas, Professor A. Penck, Professor T. W. Edgeworth David, Professor E. W. Brown, Sir Oliver Lodge, Professor H. Jungersen, Professor G. W. O. Howe, Dr. C. F. Juritz and Professor von Luschan.

Dr. Eugen Oberhummer, professor of geography at the University of Vienna, was appointed visiting Austrian professor to Columbia University for the academic year. Despite the war Professor Oberhummer is expected to be in residence during the second half-year. The visiting professors appointed from Russia and France, Professors Theodor Niemeyer and M. Paul Hazard, are said to have been called to military service.

Dr. Allan J. McLaughlin, of the U. S. Health Service, has been appointed health commissioner for Massachusetts.

The Quadrennial Fellowship of $1,000 of the Nantucket Maria Mitchell Association for the year June 15, 1915, to June 15, 1916, has been awarded to Miss Margaret Harwood, A.B., Radcliffe College, 1907, who has been for three years astronomical fellow of the association. Miss Harwood has elected to work at the University of California. The second fellowship of $500 has been awarded a year in advance, in order that the candidate may prepare herself for the special work undertaken by the Maria Mitchell Observatory. Miss Susan Raymond, A.B., Smith College, 1913, has received the appointment.

Dr. Johan Nordal Fischer Wille, professor of botany and director of the Botanical Garden of the University of Christiania, is visiting the botanical institutions of the United States. He is one of the foreign delegates to the celebration of the twenty-fifth anniversary of the Missouri Botanical Garden to be held at St. Louis on October 15 and 16.

The following members of the Western Reserve University medical faculty have returned from abroad: T. N. Stewart, professor of experimental medicine; J. J. R. MacLeod, professor of physiology; G. W. Todd, professor of anatomy and P. J. Hanzlik, instructor in pharmacology.

The first meeting of the new session of the Royal Geographical Society, London, will be held on November 9, when Mr. Belloc will lecture on "The Geography of the War." On November 23, Lord Bryce will deal with "The Mental Training of a Traveler," and on December 7, Miss Lowthian Bell will give an account of her recent journey in Arabia.

The death is recorded in *Nature* of George Gresswell, formerly lecturer in physical science, under the government of the Cape of Good Hope, at the Diocesan College, Rondebosch, and demonstrator of practical physiology and histology at Westminster Hospital.

A meeting of the Society for the Promotion of Industrial Education will be held at Richmond, Va., December 9–12.

We learn from the Los Angeles *Tribune* of September 29, that the collection of Mr. Henry Hemphill, recently referred to in Science, was

bequeathed to the California Academy of Sciences and is being prepared for exhibition at the Exposition by Mrs. T. S. Oldroyd, the well-known collector of California shells.

A GIFT of $15,000 a year for a period of five years has been made to the Egyptian Department of the Metropolitan Art Museum, by Mrs. Edward J. Tytus, as a memorial to her son, Robb de Peyster Tytus, who died last year.

THE British Board of Trade has arranged for a commission consisting of representatives of the Board of Trade, the Timber Trade Federation of the United Kingdom, and the Mining Association of Great Britain, to proceed to Canada and Newfoundland in order to enquire into the possibility of opening up new sources of supplies of mining timber for use in the coal mines of Great Britain.

ACCORDING to a report which has just been issued by the United States Bureau of Mines, the number of men killed in and about quarries in 1913 was 183. The number of men employed in the quarry industry was 106,278, and the death rate per 1,000 employed was 1.72, as compared with 1.88 during 1912. The number of men killed in 1912 was 213, the figures for 1913 showing a decrease of thirty deaths or 14 per cent. The figures show that the principal hazards of quarrying appear to be equally divided between explosives, falls of quarry material, and haulage. Accidents from these causes represent nearly two thirds of the fatalities. Albert H. Fay, engineer of the bureau, who compiled the statistics, makes the statement that in France the fatality rate for quarry accidents is seldom more than one in every 1,000 men employed, and in the year 1912 was even less than one. In Great Britain, for the ten years 1895 to 1904, the rate was 1.09 for every 1,000 men employed.

MINNESOTA far outranks all other states in the mining of iron ore, and during the last four years has contributed both in quantity and value considerably more than half the iron ore produced and marketed in the United States, according to the United States Geological Survey. In 1913 the total marketed production of iron ore in this country was 59,643,098 long tons, valued at $130,905,558, of which Minnesota contributed 36,603,331 tons, valued at $80,789,025. In 1912 Minnesota produced 34,249,813 long tons of iron ore, valued at $61,805,017. Because of its great wealth in iron ores and of their extended development, Minnesota ranks ninth among all the states in the total value of its mineral production. The value of the iron ore produced in the state represents considerably more than 90 per cent. of the total output. The value of the mineral products of Minnesota in 1913, exclusive of iron ore, was $5,025,508. These include the products of the stone quarries and the clay pits.

THE United States Bureau of Mines is planning a comprehensive exhibit at the Panama-Pacific Exposition. In arranging the exhibit, the bureau has had in mind, not only the value of interesting those engaged in the various mining and metallurgical industries, but also the education of the general public to a better knowledge of the magnitude of these industries and to the efforts which are honestly being made by the miners and mine operators, with the assistance of the Bureau of Mines, looking toward a more safe conduct of mining and a more efficient utilization of the products of the mines after they are won from the earth. The bureau's exhibit is located in the Palace of Mines and Metallurgy. An automatic duplex projecting machine will continuously show lantern slides illustrative of the activities of the bureau and simultaneously give descriptions of the lantern slides. Near by will be shown the lay-out of a model hospital, including a receiving room, ward room and operating room, fully equipped for demonstrations by the United States Marine Hospital Service; also a model of a change and wash house, another welfare feature which is being installed at modern mining and metallurgical operations. A plan of an ideal mining town will be shown. First-aid demonstrations will be given frequently. An air of reality will be lent to the demonstration by the removal of apparently injured men from the exhibition mine beneath the building by hel-

met and rescue crews. A complete display of rescue apparatus and safety lamps will be given in a glass smoke-room. Tests of safety lamps will be made, showing their tendency, under unfavorable conditions, to ignite explosive gas, and also showing methods of testing for explosive gas by means of their caps. An exhibit of the physical and chemical characteristics and constituents of explosives is being arranged. Visitors going through the exhibition mine will regain the surface through the radium booth in which actual radium emanations will be shown. Surrounding this radium booth, there will be complete exhibits of the various radium ores and of radium products. The metallurgy of various products will be shown by a comprehensive exhibit. The opportunity for increased efficiency in the use of fuels will be demonstrated by a device showing the proportionate amounts of fuels which go to make up the various losses incident to consumption in comparison with that which ultimately goes to useful purposes. Typical analyses of coal from the various fields will be shown by models and samples, as will also the yield of coke and by-products obtained by various coking processes. It is expected to show smoke-preventing and smoke-producing methods of stoking by means of an ingenious motion-picture device. An officer of the bureau will give his whole attention to visitors. Copies of the bureau's publications will be available for free distribution to visitors who may be particularly interested. This exhibit, in connection with the exhibition mine immediately beneath the bureau's space, should be interesting and instructive to those engaged in the mining industry and to the general public.

Mr. W. G. Vieth has sent the *Geographical Journal* an account of a new island hitherto uncharted in the Kazan-retto group (Volcano Islands). Mr. Vieth left Yokohama in the yacht *Tilikum II.* on January 24, 1914, bound for Brisbane, Australia. It was while anchoring at Point Lloyd, Bonin Islands, that news was received that a Japanese resident on Naka-Iwojima (Sulphur Island), the middle one of the Kazan-retto group, had just arrived there reporting the phenomenon. It was at once decided to alter the course of the *Tilikum II.*, in order to investigate the matter. When the yacht cleared Point Lloyd, a Japanese man-of-war had just arrived there with orders of a like nature, but as the latter stayed a few days at Point Lloyd, Mr. Vieth's boat was the first to arrive at the scene. "At about 9 A.M. on February 14," he writes, "we sighted a cloud of thick blackish smoke rapidly shooting up from the sea in column shape. About noon we came quite close to the island, which is of circular form, about 1 mile in diameter, 600 feet high, with a crater in the center, opening to the southeast. It is 3 miles distant in northwesterly direction from San Augustino, the southernmost of the Volcano group. All these measures are calculated only, as we did not attempt a landing, the violent eruptions at short intervals, sometimes accompanied by a rumbling noise, preventing our approaching nearer than, say, one third of a mile. Plenty of pumice-stone was floating in the sea in patches. The island itself shows the same yellowish-gray color, and seems to consist in bulk of the same light material. The neighboring San Augustino is of much greater height, clothed with vegetation, and rises steeply from the sea. It is uninhabited. The new island bears no sign of vegetation as yet." It is asserted that a similar island had risen in the same spot about ten years ago, but soon disappeared again.

The European situation has called attention sharply to the dependence of this country upon Germany for its potash supply, some 12 or more million dollars' worth of which is used annually in the United States for fertilizer. Another necessary mineral fertilizer for which the United States is entirely dependent upon a foreign country is sodium nitrate, over 21 million dollars' worth of which was imported from Chile last year. Deposits of sodium and potassium nitrate are known in Utah, Nevada, California, Oregon, Montana and New Mexico and have been described in publications of the Geological Survey and Bureau of Soils, but thus far no material of this kind has been

found in sufficient quantity to promise commercial value. The latest report that has come to the Geological Survey relates to a deposit in Arizona. One important domestic source of combined nitrogen is the gas works and by-product coke ovens, which in 1912 reported a recovery of ammoniacal liquor, ammonia and ammonium sulphate valued at $9,519,268. This output of by-product ammonium sulphate increased in 10 years from 17,643,507 pounds to 99,070,777 pounds, and as it is linked with the great coking industry further increases can be expected. Another domestic supply of nitrogen compounds lies in the fixation of atmospheric nitrogen by electricity. Cheap hydroelectric development is necessary to establish this industry, which would make our large agricultural and industrial interests free from the uncertainties of the foreign supply. It is hoped that the water-power legislation now before the United States Senate may promote hydroelectric development in large units and thus utilize some of the great water powers in the West in obtaining nitrogen from the air.

UNIVERSITY AND EDUCATIONAL NEWS

BAKER UNIVERSITY, Baldwin, Kan., has completed its $500,000 endowment fund, of which the general education board of New York gave $50,000. The rest was contributed by 10,000 persons, the largest gift from any one of them being $25,000. The people of Baldwin, a town of 1,200 population, gave $45,000.

ON October 14, Central College, Fayette, Mo., completed a campaign to increase the productive endowment of the college by $300,000. Of this amount the general educational board contributes $75,000. This fund increases the endowment of Central College to $500,000. The campus, buildings and equipment are valued at $300,000.

ON October 9 exercises in connection with the laying of the corner stone of the new chemical laboratory at the University of Illinois were held. Addresses were given by Professor William A. Noyes, director of the chemical laboratory and by William Hoskins of Chicago. The exercises were presided over by the Hon. W. L. Abbott, president of the board of trustees and President Edmund J. James laid the corner stone. The entire laboratory when completed will be 231 feet long, 202 feet wide and will contain 164,288 square feet of usable space.

AN addition is being built to the chemistry building of the University of California, costing, with its equipment, $40,000. It will provide laboratory accommodation for 250 students.

THE uncompleted University Hall of Columbia University, which contains the power house, the gymnasium and the commons, was seriously injured by fire on the night of October 9.

A HISTORY of the University of Colorado is being compiled by Professor James F. Willard and his assistants. It will probably be published within a year.

THE medical school of the University of Pennsylvania admits women this year for the first time to the regular course.

THE registration at Harvard University, with the figures for the last year given in parentheses, is as follows: Out of course, 50; seniors (361), 425; juniors (487), 581; sophomores (741), 575; freshmen (622), 704; special (19), 12; unclassified (97), 115; totals (2,327), 2,462; Graduate School of Applied Science (114), 111; Graduate School of Arts and Sciences (426), 467; Graduate School of Business Administration (104), 142; Divinity School (45), 42; Law School (647), 668; Medical School (290), 325; Dental School (185), 190; grand totals (4,138), 4,407.

THE following changes have been made in the faculty of the Case School of Applied Sciences: Professor R. H. Danforth, who has been professor of mechanical engineering at the United States Naval Academy, professor of mechanics and hydraulics; Mr. R. O. Jackson, graduate of the University of Maine and for some time engaged in practical engineering work, instructor in mechanical engineering; Mr. B. C. Boer, instructor in descrip-

tive geometry in Iowa State University, instructor in drawing and descriptive geometry; Mr. M. G. Edwards, graduate student in the University of Wisconsin, instructor in geology and mineralogy; Mr. T. D. Bains, Jr., a practical mining operator in California, instructor in mining engineering. The salaries of the full professors in Case School of Applied Science have been raised to $3,500.

Professor Perry B. Perkins has been called to the chair of mechanics at Brown University.

Dr. M. O. Tripp has been appointed professor of mathematics at Olivet College.

Dr. John B. Leathes, professor of pathological chemistry in the University of Toronto, leaves Toronto in December for Sheffield, England, where he has been appointed professor of physiology in the University of Sheffield.

Dr. A. W. Stewart, lecturer in organic chemistry in the Queen's University of Belfast, and formerly lecturer in stereochemistry at the University College, London, has been appointed lecturer in physical chemistry at the University of Glasgow, in succession to Professor Soddy, now of Aberdeen.

Dr. D. Waterston, professor of anatomy in King's College, London, has been appointed to succeed Professor J. Musgrove as Bute professor of anatomy in the University of St. Andrews.

DISCUSSION AND CORRESPONDENCE

DR. BATESON'S PRESIDENTIAL ADDRESS

To the Editor of Science: If a more extraordinary example of the inverted pyramid in reasoning than is comprised in the two Australian addresses by Bateson, lately published in Science, has ever been offered to a scientific audience I have never seen it. Offered as these were chiefly to a lay audience they are incomprehensible as coming from a man who has reached the presidency of the British Association.

We may admit the value of the Mendelian discovery in its relation to low and relatively simple organisms like plants, and also that in higher organisms Mendelian effects can sometimes be traced, but that unbridled hypothesis should be permitted to cover our colossal ignorance is not what we expect from such a source. When the observed facts flatly contradict a hypothesis a truly scientific expositor says "I can not account for it," and does not cover up (to the lay mind) his ignorance by the phrase of "an inhibiting factor." What is an "inhibiting factor?" Nobody knows. When the Mendelian law proves to fail utterly, as in the notorious case of the mulatto, the assumption of "excessive segregation" means nothing but "I do not know."

Any case can be "proved," by such methods but they are not scientific.

When a train is not on time it is doubtless due to "an inhibiting factor," but that explanation will hardly satisfy an impatient man who is anxious to be off, nor a railway manager seeking efficiency in his railway work.

If we assume the origin of life in a simple ameboid organism, without a soma, and the development of a rudimentary soma through natural selection, as a protection against the direct impact of the environment; and then the gradual complexity of the somatic envelope until it reaches its present grade in the higher vertebrates, what is the relation of the "germ-plasm" to the soma?

We may tolerate the theory of the continuity of the germ-plasm because it seems to fit the known facts. If it had never acquired a somatic envelope there would be nothing but ameboid organisms to this day. But to what does the germ-plasm as carried by the present generation of animal life owe its existence? Its potentiality of cell-division depends for continuity upon the nutrition furnished by the soma. Is it creditable that in hundreds of millions of evolving generations the constantly renewed germ-plasm should remain unmodified and that in an ameba there should exist unawakened the factors for hair, teeth, bones and hoofs? The idea seems to the writer preposterous. If the plasma has not changed its characters and potentialities since the ameboid epoch, why should there be anything now but amebas? If through the slow

modification of the soma the potentialities of the germ-plasm have been added to and modified, then the dispute as to the inheritance of acquired characters is a futile logomachy.

The original somatic envelope must have been derived from the original plasma. Why then should their mutual potentialities be denied?

WM. H. DALL

September 8, 1914

HEREDITY AND MENTAL TRAITS

TO THE EDITOR OF SCIENCE: In the admirable address of Professor William Bateson[1] surveying the bearing of modern views of heredity upon psychological and social problems, one admires particularly the staunch presentation of a consistent scheme of inherited traits and the readiness to apply them to a biological view of the social forces in whose intimate workings we have acquired so minute an interest. The same applies to the qualities of mind, of which alone I shall speak. One characteristic utterance is the following:

> I have confidence that the artistic gifts of mankind will prove to be due not to something added to the make-up of an ordinary man, but to the absence of factors which in the normal person inhibit the development of these gifts. They are almost beyond doubt to be looked upon as *releases* of powers normally suppressed. The instrument is there, but is ''stopped down.''

A very differently characteristic expression occurs in comment upon the opinion of Tom Paine inveighing against the notion of hereditary political institutions, which he regards as equally absurd as a "hereditary wise man" or a "hereditary mathematician."

> We on the contrary would feel it something of a puzzle if two parents, both mathematically gifted, had any children *not* mathematicians.

The point which I wish to raise interrogatively rather than critically is this: How far have the holders of such views—for there are many similar expressions in the recent literature—considered the problem of the assumptive nature of the unit of mental expression which is involved in such concepts as "artistic gift," "mathematically gifted?" Take the last of the expressions, and put the matter in extreme form: Suppose both parents to have specialized on quaternions, would one expect the children also to be quaternionists? Would it answer the biological requirement if the children showed ability in physics? in engineering? in science in general of any quantitative form? in a facility for abstract thought, say philosophical or economic? in a taste for study and an intellectual type of mind? Where shall we stop in considering that the trait in the child is of the same nature as the trait in the parents? We seemingly expect that the children of musicians will be musical and not the one a painter and the other a musician; on what is that expectation based, biologically considered? In brief it seems impossible to discuss mental heredity without coming to some understanding of its evidences and the modes of its expression. The equation is defective without a specific reference to the meaning of both sets of terms. Quite probably the definition is beset with large uncertainties; but it seems to a psychologist that the writers upon heredity, in applying their principles to mental traits, are in duty bound to bring the conception of a mental trait within the scheme of their considerations.

Similarly one asks in the same spirit of seeking information, why artistic gifts are in the nature of a *release* of powers which everybody has but few show, and why are mathematical gifts not of the same description? Is it the sensory dependence of the musical gift that places it in one category, which is a different category from that of the mathematical gift? And fundamentally is there such a thing as either? If so is there also a gift for steam-engineering? and why not? And what would have become of one of similar brain inheritance if he happened to be born before the days of steam? The reduction ad absurdum lies near at hand. The moral is simple. It enforces that the application of principles of heredity to mental traits can not go farther and go consistently until a reasonable understanding is reached of the probable nature of a unit of mental trait and of the equivalent forms of its possible expressions,

[1] SCIENCE, September 4, 1914.

The question of the degrees and distributions of heredity awaits a proper mode of recognition of the presence of the inherited traits. These are not as obvious as tallness or color in peas; they must in some reasonable way be made distinguishable and recognizable before their evidence can support the principles which they doubtless embody.

JOSEPH JASTROW

MADISON, WIS.,
September 21

QUANTITY AND RANK OF UNIVERSITY ATTENDANCE

RECENTLY published statistics on student attendance at our leading colleges are more notable because of certain necessary conclusions omitted than for inferences plainly intended to be drawn. The figures are overwhelmingly convincing when quantity alone is considered. When we attempt to evaluate university powers for administrating to the advancement of civilization—the primal purpose for which these institutions are established—naked quantity is the one factor of all which we should most wish to forget. Quality is the feature which ought to be most assiduously cultivated. It is not what goes into the mill, but what comes out of it, that counts.

In this last conspectus of attendance, for example, thirty American universities are considered. From institutions having the highest number of students, where the figures reach nearly 10,000, there is graduated precedence down to the thirtieth and last worth mentioning school. This last listed school becomes especially conspicuous because of the fact that its place is last.

The attendance table mentioned might have placed even greater emphasis on the quantity feature. Only the two hundred odd graduate students of this thirtieth and last listed institution might have been taken into account and this thirtieth school would then be made to assume the rôle of the tail-ender among 400 colleges of the land. But it is in this small body of students that lies the very essence of that quality of mental aptitude to which special attention is here directed, and which is entirely overlooked in the comparison.

Now it so happens that we have some very exact figures by which to express the quality of American intellectuality. They are far more reliable than any statistics which relate to mere numbers, because of the fact that they represent the mature and composite opinion of our most eminent scientific minds. It is well known how, by the one hundred authorities in science, there were selected the names of 1,000 men most distinguished in the several branches of knowledge; and how this list was recently published by Prof. J. McKeen Cattell.

Among the thousand American men of science who have become during their generation especially distinguished, who have maintained themselves as leading figures in advanced thought of the nation, and who have acquired something of an international reputation let us briefly trace the spell of the last and thirtieth school—the Johns Hopkins University. In the accompanying table is given the number out of the thousand of "starred" men who belong in each of the twelve principal branches of science. Then follows the number out of each group which has been directly associated with the Johns Hopkins University. In the third column are the percentages of Johns Hopkins men in each department.

Department	No.	. H. U.	Per Cent.
Pathology	60	18	30
Chemistry	175	35	20
Astronomy	50	5	10
Zoology	150	35	23
Anthropology	20	0	0
Psychology	50	10	20
Mathematics	80	20	25
Geology	100	25	25
Physics	150	47	31
Botany	100	8	8
Physiology	40	22	55
Anatomy	25	15	60
Totals	1,000	240	

During the next generation, in spite of loud prediction to the contrary, these percentages will probably increase rather than diminish. The first generation of Hopkins men is yet in its prime. In a remarkable way it is copiously and creatively productive. Over all American competitors it has the start of 20 years. Whether in the third generation there

may be a falling off is a matter of conjecture. It depends upon several factors. The growth of the graduate school in the larger universities and in the state universities is an essential element, but not a disturbing one so long as college and university are reared side by side, and college spirit submerges and smothers university soul.

Thus is one fourth of all the master minds in American science a direct product of Johns Hopkins influence. So is 25 per cent. of all American scientific thought impelled by the mainspring of Baltimore. It is not quantity of university influx but quality of university output that is telling and worth while.

CHARLES KEYES

THE FUR SEAL INQUIRY, THE CONGRESSIONAL COMMITTEE AND THE SCIENTIST

SOME three years ago the "Committee on Expenditures in the Department of Commerce" of the House of Representatives, headed by Congressman Rothermel of Pennsylvania, undertook the investigation of the work of the Bureau of Fisheries on the administration of the fur seal fisheries, apparently with the definite purpose of discrediting, for political reasons, this branch of the government service. In February, 1909, there had been appointed an advisory board of the fur seal work, consisting of the following well-known zoologists, David Starr Jordan, C. Hart Merriam, Charles H. Townsend, Leonhard Stejneger and Frederic A. Lucas, to serve without pay in advising the government as to the best means of regulating the killing and the protection of the fur seals on the Pribilof Islands.

To discredit the work of the administration of the seal fisheries it was necessary also to discredit these men. The fact that they served without pay was of course open to suspicion to the machine type of politician, who naturally finds it difficult to conceive of any one doing any work for the government with no emolument attached thereto. Accordingly the majority of the committee proceeded to measure them according to their own standard and took up charges which had been filed against all and sundry by one Henry W. Elliott. This man Elliott, it may be mentioned, is a disgruntled ex-employee of the government who was dismissed in 1891 because he had been "found guilty of grave improprieties." For more than twenty years this man had persistently brought charges, not only against all the scientific men who opposed his propositions, but against seven secretaries of departments, besides senators and congressmen. These charges had been repeatedly disproved and their author discredited and officially branded as "a person unworthy of belief."

However, this repeated repudiation of the Elliott charges did not prevent the committee from taking them up again in the attempt to make political capital of them. In the face of all the testimony submitted at the hearings and on the unsupported evidence of the man who preferred the charges, the majority of the committee found in favor of the charges.

To their everlasting credit be it said that a minority of the members of this committee were so incensed at the findings of the majority in direct face of the evidence, that they insisted on presenting a minority report (Report 500, Pt. 2, 63rd Congress, 2d Session, Fur Seal Industry of Alaska, 22 pages, July 27, 1914, signed by Congressmen McGuire and Patton). This report is a scathing arraignment of the methods of procedure and the findings of the majority and of Elliott who brought the charges. A few excerpts may not be amiss here.

> The charges preferred by Elliott are without foundation in fact,—the same charges have been preferred by him with regularity for over 20 years to various committees of Congress and executive departments, and in each case found to have been groundless.
>
> Elliott, the author of these charges and the sole witness in support of them, is a person unworthy of belief and one who has been consistently repudiated in the past.
>
> The committee had no justification for the reopening of these hearings on the same charges.
>
> There is a total absence of evidence of any irregularities on their (the government's representatives) part.

Notwithstanding this well-known record, which demonstrated Elliott to be actuated by motives which rendered him wholly unreliable as a counselor in matters pertaining to this question, it is nevertheless the fact that this committee in 1911 took up these old Elliott charges—now repeated with renewed vehemence, but with no more basis of fact—erected Elliott in its midst as prosecuting witness and amicus curiæ, accepted his mere unsupported assertions of fraud and illegality as proof thereof, endeavored by every means in its power to substantiate them, and strove by severe cross examination to nullify as far as possible the effect of testimony of witnesses appearing in their own defense to answer charges. The hearings have covered thousands of pages of printed testimony.

The minority report recommends that the Department of Justice investigate Elliott with a view to bringing charges for the misuse of congressmen's franks by sending out under them abusive and defamatory matter to witnesses before the committee and for perjury under various heads, and that a joint committee of Congress be appointed to investigate "all proceedings in connection with the investigation as conducted by this committee."

It is interesting to note that of the original committee who presented the majority report, Congressman McDermott was compelled to resign from Congress owing to his connection with the disgraceful Mulhall disclosures, while Rothermel, the chairman of the committee, who was particularly vindictive in the prosecution, failed to secure renomination in his home district after charges had been made against him on the floor of the House for improper and illegal use of funds allotted to his committee.

The Rothermel committee sent Elliott as an investigator to the seal islands during the summer of 1913, a proceeding which the minority report brands as "nothing but a farce" on the grounds that "if the object of the committee had been the substantiation of the Elliott charges, it could not have adopted a more certain means of accomplishing this result than by sending Elliott himself." However, it seems that the committee overstepped its authority in doing this and Congress has refused to refund the expenses of the trip.

There is a verse concerning a mountain, which after great labor, brought forth a mouse. The work of the congressional committee headed by Rothermel has produced similar valuable results. The fiasco has been a very expensive one, however. It has cost the country many thousands of dollars, it has further endangered the existence of the seal herd already depleted by many years of pelagic sealing, it has caused the loss to the Bureau of Fisheries of the services of the eminent ichthyologist Dr. Barton W. Evermann, who has since become director of the museum of the California Academy of Sciences, and has inflicted needless expense, humiliation and irritation upon the scientists who formed the advisory board. As far as the scientific standing of these men is concerned, it is not necessary to remark that it will not suffer in the least on account of this political attempt to discredit them.

It should be mentioned that the Bureau of Fisheries has had no part whatever in these attacks on the scientists mentioned and that whatever changes have been made in the plan of conducting the seal work have been those prescribed by law. Whatever may have been the attitude in the past, of the Department of Commerce, under which the Bureau of Fisheries is placed, it is evidently desirous of learning the truth in regard to the work on the Pribilofs, for Secretary Redfield this past summer sent a special committee of three zoologists to the islands to investigate and report upon conditions there. At his request, one of these was nominated by the Department of Agriculture, one by the Smithsonian Institution and one by the National Academy of Sciences. While none of these men has had any previous acquaintance with work on the islands, they will at least be able to give an entirely unprejudiced report, even if they are unable to make any comparison with past conditions. The Dominion of Canada and Japan have also sent investigators to the seal islands. The report of this committee is awaited with interest.

RAYMOND C. OSBURN
COLUMBIA UNIVERSITY,
September 12, 1914

SCIENTIFIC BOOKS

RECENT BOOKS ON MATHEMATICS

Memorabilia Mathematica or The Philomath's Quotation-book. By ROBERT EDOUARD MORITZ, Ph.D., Ph.N.D., Professor of Mathematics in the University of Washington. New York, The Macmillan Company. 1914. Pp. vii + 410.

Analytical Geometry of Space. By VIRGIL SNYDER, Ph.D., Professor of Mathematics at Cornell University, and C. H. SISAM, Ph.D., Assistant Professor of Mathematics at the University of Illinois. New York, Henry Holt and Company. 1914. Pp. xi + 285.

Analytic Geometry and Principles of Algebra. By ALEXANDER ZIWET, Professor of Mathematics, the University of Michigan, and LOUIS ALLEN HOPKINS, Instructor in Mathematics, the University of Michigan. New York, The Macmillan Company. 1913. Pp. viii + 369.

Higher Algebra. By HERBERT E. HAWKES, Ph.D., Professor of Mathematics in Columbia University. Boston, Ginn and Company. Pp. iv + 222.

Industrial Mathematics. By HORACE WILMAR MARSH, Head of Department of Mathematics, School of Science and Technology, Pratt Institute, with the collaboration of ANNIE GRISWOLD FORDYCE MARSH. New York, John Wiley and Sons. 1913. Pp. viii + 477.

Trigonometry. By ALFRED MONROE KENYON, Professor of Mathematics, Purdue University, and LOUIS INGOLD, Assistant Professor of Mathematics, the University of Missouri. Edited by EARL RAYMOND HEDRICK. New York, the Macmillan Company. 1913. Pp. xi + 132 + xvii + 124.

Trigonometry for Schools and Colleges. By FREDERIC ANDEREGG, A.M., Professor of Mathematics in Oberlin College, and EDWARD DRAKE ROE, JR., Ph.D., Professor of Mathematics in Syracuse University. Boston, Ginn and Company. Pp. viii + 108.

Advanced Algebra. By JOS. V. COLLINS, Ph.D., Professor of Mathematics, State Normal School, Stevens Point, Wisconsin. New York, American Book Company. 1913. Pp. x + 342.

The Algebra of Logic. By LOUIS COUTURAT. Authorized translation by LYDIA GILLINGHAM ROBINSON, B.A., with a Preface by PHILIP E. B. JOURDAIN, M.A. (Cantab.). 1914. Chicago and London: The Open Court Publishing Company. Pp. xiv + 98.

A History of Japanese Mathematics. By DAVID EUGENE SMITH and YOSHIO MIKAMI. Chicago, The Open Court Publishing Company. 1914. Pp. v + 288.

Thousands of readers will be grateful to the author and the publishers for a work that is so beautiful, both physically and spiritually, as the "Memorabilia." The ideal that requires us to dispense entirely with authority and to hold no beliefs and form no judgments not based on evidence examined by ourselves is not attainable. If it were, it would not be an ideal. In the future it will be necessary, as it has been in the past, for all men and women to depend for the most part upon borrowed estimates. Even if it were not, we should still value as such the opinions of others, especially when expressed in worthy and lasting form. In view of such considerations such an undertaking as that of Professor Moritz is amply justified and especially so because this work of his is the first of its kind in the English language. Nor has he, except in the case of "a small number of famous utterances," duplicated Rebiere's "Mathématiques et Mathematiciens" or the "Scherz und Ernst in der Mathematik" of Ahrens. We have here more than a thousand utterances of more than three hundred authors regarding the nature and value of mathematics. The quotations vary in length from a line to several scores of lines, and all of them are in English. In the case of borrowed translations, the translator's name is given. At the end of each passage there are given the author's name and the source of the extract. An attempt to group the material under heads has resulted in dividing the volume into twenty-one chapters. Moreover, the final index refers to nearly seven hundred topics. The list of authors,

which represents all historic times, includes not only mathematicians but students of natural science, poets, philosophers, statesmen, theologians and historians. In respect of fame these range from the obscure to the world-renowned. Various criteria were used for determining the admissibility of passages, as eminence of the author, fitness of content, felicity of expression. Even Shakespeare contributes three passages and Goethe ten. One of these is: "Mathematics, like dialectics, is an organ of the inner higher sense; in its execution it is an art like eloquence. Both alike care nothing for the content, to both nothing is of value but the form." Gauss contributes 10 passages, Poincaró 5, Plato 9, Emerson 2, Euripides 1, Descartes 11, Newton 7, Leibnitz 8, Laplace 13, Daniel Webster 1, Pliny 1, Dante 2, and so on. It is difficult to imagine that any teacher, student or scholar could fail to find instruction and delight in this book of gems.

Professors Snyder and Sisam's book will meet the demand of those who desire a larger knowledge of the analytical geometry of three dimensions than is afforded by the usual first-course books on analytical geometry and who find such works as those of Salmon and Frost too extensive. The first eight chapters present the usual matter but the remaining six chapters of about 180 pages will serve admirably as a basis for an undergraduate advanced elective in the subject; the main topics here treated being tetrahedral coordinates, quadratic surfaces in tetrahedral coordinates, linear systems of quadrics, transformations of space, curves and surfaces in tetrahedral coordinates, and differential geometry of curves and surfaces. There is appended a list of answers to the exercises. Graduate students should come with such preparation as this book yields.

Among the commendable features of Ziwet and Hopkins's book are the treatment of algebraic topics usually presupposed by or studied simultaneously with first lessons on analytical geometry, the early introduction of the use of determinants, the emphasis upon the straight line and the circle as preliminary loci, the attention given to the plotting of polynomials before attacking the conics, and the employment of the notion of the derivative of polynomials. The doctrine of poles and polars is presented only in relation to the circle. The concept of a vector is introduced in connection with applications to mechanics. The elements of the geometry of space occupy 78 pages. Portions that may be omitted are in small type. Answers are given.

Professor Hawkes's book opens with a chapter of 22 pages devoted to a review extending through linear equations in two variables. Functions and their graphs occupy the next chapter (14 pages). Recognizing that a student who would proceed to analytical geometry, the calculus or the theory of higher equations must gain a thorough knowledge of the quadratic equation, the author has devoted a chapter of 27 pages to this important subject. It is handled admirably. A very brief presentation of inequalities is followed by an excellent chapter on complex numbers. There follows a chapter of 75 pages dealing with elements of the theory of the general equation in one unknown. A notable feature is the presentation of Horner's method. The notion of derivative of a polynomial is introduced. Permutations, combinations and probability claim ten pages, followed by the elements of determinant theory. Then follow chapters on partial fractions, logarithms and infinite series. The book closes with some short tables, and a good index. The work is notably successful in its endeavor to make theory and practise reciprocally helpful.

Mr. Marsh's thick volume contains a mass of information designed to enable "industrial" folk to use mathematics without really studying the subject beyond the initial steps. It begins with arithmetic. After much useful direction in a great variety of mensurations, the solution of simple equations is reached on page 354. Mathematical theory is present in only infinitesimal amounts, sometimes of higher order, whilst practise swells toward the infinite. The reader is told how to do things, even how to solve triangles by use of logarithmic tables. The work will help many who are very ignorant of mathematical science. One

of its possible services is that of awakening in the reader a desire to understand the ghostly theory that lurks behind the practician's rules. I shall never forget how unhappy I was made when a boy by having to learn by heart and to use the rule for computing the area of a triangle in terms of its sides before looking into a geometry and what a burden was rolled off when in subsequent years I learned to deduce the rule. Industrial folk will not find it easy to circumvent the necessity of understanding something of the science they would use. The way of the transgressor is hard.

Among the more notable features of Professor Kenyon and Professor Ingold's "Trigonometry" are the prominence given to the solution of triangles, first by geometric methods, then gradually by means of the trigonometric functions and logarithms; the use of composition and resolution of forces to show the significance of large angles and of addition formulæ; the hinging of the treatment on a minimum of theoretical considerations; the very large number and variety of exercises and applications; the omission of DeMoivre's theorem and of infinite series; the presence of a rather extensive chapter on spherical trigonometry, and the inclusion of 124 pages of convenient tables.

The attractiveness of the admirable little volume of Professors Anderegg and Roe is due partly to its smallness. The smallness is due in some measure to conciseness but mainly to omission of tables, model arithmetical solutions, a list of answers and an index. A large part of the book deals with spherical trigonometry. It is shown that plane trigonometry is a special case of spherical. It is evident that the authors are fascinated with the theory of the subject, and their treatment of it looks up toward higher analysis rather than merely down to practical uses and computation.

As we open Professor Collins's "Advanced Algebra" it is pleasant to be greeted by a genial likeness of Sylvester and, as we pass on, to encounter the pictures of Tartaglia, Cauchy and Gauss, with brief accounts of them. A first-year course is presupposed. The book falls into three parts, devoted respectively to a review, to the remaining topics of elementary algebra, and to such college topics as general equation theory, probability, determinants and infinite series. The author's aim has been to equip the student to meet either of the two algebra standards of the College Entrance Board and to carry him well into college topics.

Many students of modern logic will welcome Miss Robinson's excellent English translation of Dr. Couturat's well-known "L'Algèbre de la logique." This edition is distinctly enhanced by the preface prepared by Mr. Jourdain. Here and now are not the place and time to review the content of a work of which the original French edition was published in 1905. Suffice it to say that it consists of the elements of the classic logic of exclusion and inclusion presented in algebraic garb and that the algebra of logic is not to be confounded with what is known as the logic of mathematics.

From the mathematical public thanks are due Professor Smith, Mr. Mikami and the Open Court Publishing Company for their "History of Japanese Mathematics." Owing to the wellnigh complete insulation of the Japanese until recently from the western world, this first English account of their mathematical work is a real romance in the austere things of the human spirit—almost as fascinating as would be a message from Mars. We confess to having read every line of it with eager and increasing interest. Not only will all liberal students and teachers of mathematics wish to read it but it is rich in material for psychologists, historians and other scientific students. In particular may anthropologists find in it evidence both for and against the thesis that similarity or dissimilarity of circumstances determines similarity or dissimilarity of intellectual developments. Even if space allowed it would be a kind of injustice to delineate the content of this volume here and so deprive the reader of it of the pleasure of meeting its surprises first-hand. Suffice it to say that the numerous beautiful photographic illustrations (made by Mr. L. L. Lock)

are themselves well worth the price of the volume.

CASSIUS J. KEYSER

A Dictionary of Applied Chemistry. By SIR EDWARD THORPE. Longmans, Green & Company. 5 vols., 800 pp. each. Price $13.50.

Samuel Johnson, to use his words, "noting whatever might be of use to ascertain or illustrate any word or phrase, accumulated in time the materials of a dictionary." A proper dictionary of chemistry might then well be a collection of whatever information might be of use in ascertaining and illustrating words and phrases of chemical usage. Some such broad foundation was used in the dictionary at hand.

Thorpe's "Dictionary of Applied Chemistry," first published in 1890, has ever since been such a well-known dictionary that a review of this new and enlarged edition need concern only the completeness of the accumulations since then. It is clear that no other English work contains so much information of chemical nature. As it also gives the main references to literature on many subjects, it is difficult to conceive of any improvement which the chemist might fairly expect. There are now five volumes, as against three in 1898. Emerson's reference to dictionaries, in his essay on Books, is particularly fitting when shorn of any points of irony: "Neither is a dictionary a bad book to read. There is no cant in it, no excess of explanation, and it is full of suggestions—the raw material of possible poems and histories." This has all seemed very pertinent to me in reading the "illustrations" of some of the chemical words. "Absorption spectra and chemical composition" has charm and rhythm that must be poetry to every real chemist. The brief accounts of such perennially youthful patriarchs as iron, tungsten, boron, etc., are free from "cant" and "excess," and are powerful new history. The Frash process, by which practically all the sulphur in the United States is now produced, is a very interesting story and particularly to those who know only of the Sicilian sulphur of the older books.

Hardly a single chemical element has been "dead" since the publication of the first edition of this Dictionary, and therefore they all had their history rewritten. Then almost no hydrogen was technically applied, no oxygen manufactured, no aluminum sold. Silicon, tantalum, argon and radium were all practically unheard of.

A great deal had to be written to "illustrate" the words of modern applied chemistry, novelties of the recent period: cryoscopy, cyanamid, monel metal, metallography, etc. This has been well done, and usually by experts. Who, for example, could better describe carbon bisulphide than our own E. R. Taylor, who makes about all that is used in America? The oils, fats, waxes, etc., have been cared for by Lewkowitsch, water by Frankland, potash by Lunge, radioactivity by Bragg, cellulose by Cross, and paper by Bevan, dyes by Perkin, and acetylene by Lewes. Thus scores of the most prominent chemists of all nations have aided the work.

A few more of the indicators used to determine that the work has been brought up to date may well be mentioned. The ancient and interesting "suffoni" are now partly displaced by California mines of colemanite as a source of boric acid. Cement is now burned in rotating kilns of 150 feet length. Oxyhydrogen and oxyacetylene metal cutting are well described. Chemical affinity, equilibria and catalysis are living subjects evidently still being studied at the time of going to press, and they are made comprehensive by articles of breadth. Bordet's and Ehrlich's different views of the interaction of toxins and antitoxins are disclosed. The Claude and the Linde air liquefaction processes and the liquefaction work on hydrogen and helium by Travers and Olszewski are fully described. Four different uses of the word ferrite are described, which ought to militate a little against the use of this word for any other newly discovered material.

Chemical analysis is treated in 100 pages as compared with 57 of the 1898 edition: Azo colors in 38 pages, as against 28; carbohydrates, 24 as against 4; naphthalene, 102, in place of 65; ozone 8 against $2\frac{1}{2}$; rust and corrosion of iron 11 against $2\frac{1}{2}$; spectrum analysis 30

against 20. The additional space devoted to such subjects is usually distributed well. One or two subjects might still be extended. For example, iron (including all steels) is covered in twenty pages, one fifth that devoted to naphthalene. No mention of electric furnace steel products is made. Such subjects as metallography (21 pp.), toxins and antitoxins (4), colloids (4), utilization of atmospheric nitrogen (12), radioactivity (11), and many others appear for the first time. These representatives will also serve to indicate that the dictionary is not so closely confined to applied chemistry as the earlier editions. In many of the topics the completeness is quite remarkable and frequently includes references to patents containing matter not found in other published researches, and therefore not generally available.

W. R. WHITNEY

Catalogue of Scientific Papers. Fourth Series (1884–1900). Compiled by the Royal Society of London. Vol. XIII., A–B. Cambridge, University Press. 1914.

The first incentive to the monumental undertaking of which the present volume marks the beginning of the end in its original form, came from America, in a communication from Professor Joseph Henry to the British Association at Glasgow in 1855, suggesting the formation of a catalogue of philosophical memoirs, which was favorably reported upon by a committee of the Association in the following year. Six volumes, in quarto, covering the scientific periodical literature from 1800 to 1863, were issued under the superintendence of the Royal Society from 1867–72, and were followed by two volumes, covering 1864–73, in 1877–9, three volumes, covering 1874–83, in 1891–6, and a supplementary volume, covering literature of 1800–83 not hitherto indexed, in 1902. The present volume is the beginning of a series which will cover all papers published or read during 1884–1900, completing the catalogue for the whole of the nineteenth century. The four series, when completed, will thus comprise a complete author catalogue of the scientific literature of 1800–1900, no subject rubrics being employed. All scientific literature published after the end of 1900 has been in the hands of the authorities of the International Catalogue of Scientific Literature, and since 1907 has been issued in the form of subject bibliographies of the fundamental sciences by the International Council of the Royal Society.

Before the Royal Society undertook this work, there had been, from the time of Conrad Gesner's "Bibliotheca Universalis" (1545–49), other bibliographies of similar scope, such as the "Repertorium commentationum" of J. D. Reuss (1800–21), which was confined to society transactions and not limited to scientific papers, or the "Gelehrten-Lexicon" of C. G. Jöcher (1750–51), continued by Adelung and Rotermund (1784–1819), with a final volume by Rotermund (1897). In the year of the Royal Society's first venture in this field (1865), the physicist, J. C. Poggendorff (of Poggendorff's *Annalen*) published his "Biographisch-literarisches Handwörterbuch," containing biographical bibliographies of 8,400 scientists, which was continued for the years 1858–83 by Feddersen and von Oettingen in 1898, and to 1904 by the latter. Of exhaustive bibliographies of special subjects, many of which are listed in Petzholdt's "Bibliotheca Bibliographica" (1866), there have been such striking examples as those of Haller in botany (1771–2), anatomy (1774–7), surgery (1774–7) and internal medicine (1776–8); A. G. Kästner in mathematics (1796–1800); C. P. Callisen's 33-volume catalogue on the medical literature of his time (1830–45); L. Agassiz in zoology and geology (1848–54), and such later works as those of Waring in therapeutics (1878), R. Schmid in public hygiene (1898–1906), Laehr in neurology (1900), Stiles and Hassall in parasitology (1900–2), and Abderhalden in alcoholism (1904). The entire literature of medicine has been covered, both for authors and subjects, in the well-known "Index Catalogue" of J. S. Billings (1880–1914), now nearing its completion. The author catalogue of the Royal Society forms at once a supplement and a complement to all these, containing many titles not to be

found anywhere else. The immense proliferation of scientific literature in seventeen years alone (1884–1900) may be judged by the fact that the present volumes, of 951 double-column pages in small type, covers only letters A–B. This is due to the fact that, in addition to periodicals and serials devoted to pure science, many publications of lighter weight have been indexed, as containing occasional contributions of value. The list of new abbreviations covers some 90 pages. In this we find such titles as *L'Abeille* (entomology), the *Analyst* (chemistry), *Aquila* (ornithology), the *Electrician, Garden and Forest*, the *Humming Bird*, the *Sidereal Messenger*, the *Wombat*, the *Journal of Tropical Medicine*, the *New York Medical Journal* and the *Practitioner*. Such titles do not, however, connote triviality, but the editors admit that the selection of material in the less exactly defined sciences, such as anthropology or geography, can not be made from a rigid viewpoint. Not presuming to go outside the medical sciences, a number of titles might be noted which are nowise reports of original work, but *articles d'actualité*, abstracts or *résumés* of work done by others, a species of ephemeral literature in which medicine, more than any other group of sciences, abounds. Any one familiar with medical bibliography will realize how unavoidable such inclusions are; but in the more rigorous branches of science there is little chance for vulgarization, and "abstracts" are usually described as such. One very valuable feature of this catalogue consists in the well-selected obituaries and memorial notices of deceased individuals, for instance those of the surgeon Billroth (p. 558) or the physiologist Brown-Séquard (p. 851). The system of Russian transliteration adopted is a new departure. In the twelve volumes preceding, the standard used was a table, approved by Löwinson-Lessing, Morfill and other Russian scholars, and adopted by the British Museum, the Royal Society and other learned bodies in England.[1] The present system, which is also employed in the "International Catalogue of Scientific Literature," is based on the phonetic value of Roman letters in Bohemian. Thus what was formerly written *zh* becomes *ž*, *kh* becomes *ch*, *ch* becomes *č*, *sh* becomes *š*, and *shch* becomes *šč*, *ya* or *yu* becomes *ja* or *ju* at the beginning of a syllable and *ia* or *iu* after a syllabic consonant. These improvements will undoubtedly make for less unsightly names or words in print, and, if standardized, may mercifully settle the vexed question of Russian transliteration. In the present catalogue, however, it has been necessary to employ cross references to facilitate identification with names in earlier volumes transliterated after the old method. One of the great difficulties in cataloguing Russian names is the fact that German or other non-Russian names in Russian text are often violently wrenched from their true orthography, making strange appearances when rendered by certain transliterators. Thus *Wales* becomes *Uels*, *Herzen* becomes *Gertsen*, *Zoege-Manteuffel* becomes *Tsege-Mantaiffel* and *Poehl* is written *Pel*. The difficulty is further complicated by the fact that many Russian writers of Yiddish extraction who bear German names decline to spell such names German fashion, when written in Roman characters, adhering to a servile transliteration of the Russian. This is very commonly seen in the students' dissertations of Berne and Zürich, where Jewish pupils abound. Even before the days of Yuryev and Petrograd, it was necessary for the bibliographer to have a certain *flair*, an actual *science des noms* in Russian transliteration. In regard to another detail of the science of personal names, the Royal Society Catalogue has preserved throughout an admirable consistency and uniformity. Thus the prefixes *d'*, *Da*, *Dal*, *de*, *De*, *Del*, *Della*, *van*, *Van*, *von* are all lower-cased and not considered as part of the name, Da Costa appearing under Costa, and the Belgian Van Beneden along with the Dutch van Beet or the German von Bardeleben. Names preceded by *Du*, *Des*, *Mac* and *O'* are, however, found under the letters *D*, *M* and *O*, and those preceded by *La*, *Le*, *Les* are all found under the letter *L*. In English and Dutch compound names, the last name is preferred; in French, Spanish

[1] *Nature*, 1889–90, XLI., 396–97.

and Portuguese, the first. Any system of this kind, if rigidly adhered to, is of vast aid in cataloguing. How to catalogue such a name as "du Bois Reymond" is one of the ever-recurring puzzles of bibliography. In listing abbreviations, the Royal Society Committee still adheres, in many instances, to the practise of placing the locality of a given society at the head of the abbreviation of the title of its transactions, instead of after it, as ordinarily, which sometimes loses it under an unknown entry. In some cases, this difficulty is obviated by a cross reference, but the custom can not be commended. A few very trifling errors have been noted, such as the confusion of J. S. Billings, Sr. and Jr., but these are surprisingly rare in a work of such vast extent. The impeccable typography is in itself a token of accuracy in indexing. The entire series, when completed, will be one of those invaluable works which no scientific library can do without for any length of time.

F. H. GARRISON, M.D.

ARMY MEDICAL MUSEUM

THE NATIONAL CONFERENCE COMMITTEE

THE seventh conference of the National Conference Committee on Standards of Colleges and Secondary Schools was held at the rooms of the Carnegie Foundation for the Advancement of Teaching, New York, on February 28.

The following delegates were present as representatives of the organizations indicated:

Headmaster Wilson Farrand, Newark Academy, representing the College Entrance Examination Board, *President*.

Dean Frederick C. Ferry, Williams College, representing the New England Association of Colleges and Preparatory Schools, *Secretary-Treasurer*.

Professor Frank W. Nicolson, Wesleyan University, representing the New England College Entrance Certificate Board.

Dean Frederick P. Keppel, Columbia University, representing the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

Principal Frederick L. Bliss, Detroit University School, representing the North Central Association of Colleges and Secondary Schools.

Chancellor James H. Kirkland, Vanderbilt University, representing the Association of Colleges and Secondary Schools of the Southern States.

President John G. Bowman, The State University of Iowa, representing the National Association of State Universities.

Secretary Clyde Furst, as substitute for President Henry S. Pritchett, representing the Carnegie Foundation for the Advancement of Teaching.

Honorable Philander P. Claxton, the United States Commissioner of Education.

There was present also, by invitation, as a visitor, Dr. Samuel P. Capen, specialist in higher education in the National Bureau of Education.

Headmaster Wilson Farrand, president of the committee, presided at both the morning and the afternoon sessions.

The subcommittee, consisting of Headmaster Farrand (chairman), Dean Ferry, President Pritchett and Principal Bliss, gave a report of an investigation made by its chairman to ascertain the number of recitation periods per week devoted to Mathematics A, History A, History B, History C, History D and Civics (as a separate study), the year in the course when each of these subjects is taken by the pupil, and the number of periods per week which constitute the normal schedule of the pupils in the schools considered. Information had been procured from 363 schools widely scattered through the country. The results seemed to the committee to warrant the raising of the question of increasing the weight (in units) given to Mathematics A and decreasing the weight given to each of the four history subjects.

The subcommittee suggested also the consideration of the proposal presented from various sources, and particularly from the North Central Association of Colleges and Secondary Schools, that there be a discrimination among units according to the time in the secondary school curriculum when the subject is studied; *e. g.*, units of the first two years might be called "minor" units, those of the last two years "major" units, and perhaps those of the second and third years "intermediate" units. A third suggestion was to

the effect that it might be advantageous for colleges and universities to demand that a certain number of admission units, say ten or twelve, be confined to a small number of subjects, say three or four, and that only a definite minimum be made up of isolated subjects. After much discussion, it was voted without dissent that these questions be referred to the constituent bodies for consideration and advice; and for that purpose the following circular letter was later prepared by Dean Keppel and Secretary Furst for submission to the members of the organizations whose delegates constitute the National Conference Committee on Standards of Colleges and Secondary Schools:

In spite of the marked progress toward uniformity in college entrance credits, this committee is informed of certain recurring difficulties in administration. It appears, for example, from our general inquiry concerning the subject, that elementary algebra is usually given more time than is represented by the unit and a half of credit given to this subject, and that certain branches of history are usually given less time than is represented by the unit of credit that they receive. There is, on the other hand, a tendency toward a strictly mechanical interpretation of the unit, even to the point of counting minutes, which emphasizes the letter rather than the spirit of a system of merely approximate measures.

The committee realizes the importance of recommending as few changes in the regulations as possible, but it believes that it will be of service if the organizations that it represents will consider and report to the committee their official judgment or the attitude of their members toward the following suggestions:

A. That the unit credits assigned to the subjects of elementary algebra and history be modified so as to represent more nearly the amount of time given to these subjects.

B. That in certain subjects—as for example, history—the amount of credit to be assigned should not be uniform in all cases but should vary with the time and attention given.

C. That some distinction be made between the amount of credit that is given to subjects taken in the early years of the high school and those taken in the later years.

D. That there be adopted some uniform plan of limiting the number of subjects in which credit may be gained in order that continuity of work may be secured in at least two subjects.

The committee having received many requests for a uniform blank for the submission to the college of a statement of the school record, and it being understood that committees of the Association of Colleges and Preparatory Schools and of the College and University Presidents Association of Pennsylvania are already engaged in the preparation of such a paper, it was voted that the subcommittee seek information on this subject, consult with other committees, and report to the committee at its next meeting.

Commissioner Claxton asked that the National Conference Committee undertake the task of defining many terms which have come into use in modern education, school administration, etc., and have not had certain and clear meanings assigned to them. It was agreed that the committee should undertake this work with the expectation that some part of it, at least, could be successfully accomplished. It was accordingly voted that the subcommittee be instructed to take this subject under consideration with a view to the extension of the field of the committee to the desired determination of definitions and that a report be made at the next meeting.

Officers for the ensuing year were elected as follows:

President, Headmaster Wilson Farrand.
Vice-president, Chancellor James H. Kirkland.
Secretary-treasurer, Dean Frederick C. Ferry.

The choice of the subcommittee was left to the president with the provision that he serve as its chairman. The other members, as appointed by him, are Chancellor Kirkland, Dean Ferry and Dean Keppel.

FREDERICK C. FERRY,
Secretary

SPECIAL ARTICLES

THE "MULTIPLE UNIT" SYSTEM AS A SOURCE OF ELECTRICITY FOR LABORATORIES [1]

THE problem of furnishing electricity, adapted to physiologic and pharmacologic ex-

[1] From the pharmacology laboratory of the Northwestern University Medical School.

perimental work, has been satisfactorily solved in but few laboratories. Very little on the subject is found in the literature and the need of a practical method which is comprehensive and can be intelligently adopted, is becoming apparent. With this in mind the writer presents a brief discussion of the sources of electricity suitable to laboratory use, with special reference to what he terms the "multiple unit" system.

Dry batteries are extensively used chiefly because of their compactness, ease in handling and apparent cheapness. But they are not dependable, since they polarize easily, the current is not constant and the supply is limited. Because of this much time is often lost in getting apparatus to work properly. In addition the cost per year is usually a considerable item. Yet in spite of these inconveniences they still remain the common source of electrical supply. Wet batteries have the same disadvantages as dry cells. They are also clumsy and hence little used. Storage cells are fairly reliable but their bulkiness and expense make them undesirable for student work.

The direct electric lighting current is an excellent source. A suitable resistance wire is attached in series to this as a rheocord from which sufficient current may be tapped off at various points and led to different instruments. The principle involved is well known, although it appears that but few physiologic or pharmacologic laboratories are utilizing it. This shunt rheocord system has the advantage of being absolutely reliable. The current is of unlimited supply and the voltage or amperage can be either made constant or varied at will. This is important in the stimulation of tissues with the direct current, where graded amounts are desired. Such an outfit may be made compact, accessible and inexpensive; it requires little care and will last indefinitely.

The installation of such a system involves several important considerations.

First, Source.—Preferably, a direct 110-volt current should be used.

Second, Amperage Carried.—This is determined largely by (*a*) the amount of current necessary to make any instrument work properly; (*b*) the internal resistance of each, and (*c*) the number of instruments to be used and their effect upon the line amperage when shunted into the line resistance. Most inductoria of American make operate best with a current of .5 to 1 ampere and 1.5 to 2 volts. The Harvard coil has an internal resistance of about .5 ohm, but this may rise as high as 1 ohm with the interrupter in series if the contact points of the latter are poor. The Stoelting make No. 7090 has 1.5 ohms, and 2 ohms or more with the interrupter. Signal magnets all work well with 1.5 to 2 volts and .5 to 1.5 amperes. Their resistance ranges between .5 ohm and 3 or more ohms (Stoelting No. 7076—.5 ohm; Harvard—3 ohms). An induction coil in series with a magnet requires a 2 to 3 volt and a .4 to 1 ampere current. An average resistance of all the instruments is about 1.5 ohms. Practically, the above amperages may be decreased within certain limits if the voltages are correspondingly increased, and vice versa. Individual needs will determine the number of instruments to be used. In this laboratory accommodations are provided for sections of thirty-five students each, and a maximum of sixty-five instruments is permitted.

Great increases in the line current must be avoided, and in order to determine the current necessary to keep this rise in the line amperage below any desired maximum, say 15 per cent., it is of advantage to keep in mind the following formulæ:

The current in amperes (i) equals the potential in volts (e) divided by the resistance in ohms (r).

$$i = \frac{e}{r} \quad \text{or} \quad e = ir \qquad (1)$$

The conductance of two wires in parallel equals the sum of the two separate conductances, conductance being the inverse of resistance.

$$\frac{1}{r} = \frac{1}{r'} + \frac{1}{r''} \quad \text{or} \quad r = \frac{r'r''}{r' + r''} \qquad (2)$$

The amount of current passing through each of two wires in parallel is inversely proportional to its resistance.

$$i':i''=r'':r' \tag{3}$$

The amount of current passing through two wires in parallel equals the sum of the two separate currents.

$$i=i'+i''. \tag{4}$$

As an illustration, a rheocord, taking 2 amperes from a 110-volt main, has a resistance of 55 ohms (formula 1) and 2 volts drop for each ohm. Shunt in a 1.5 ohm signal magnet on this line at two points, *A* and *B*, between which there are 2 ohms and consequently 4 volts. The intervening resistance becomes by formula (2) .85 ohm and is therefore reduced 1.15 ohms. The total line then has a resistance of 53.85 ohms and a current of 2.04 amperes (formula 1). Between *A* and *B* the voltage becomes $2.04 \times .85$ or 1.75 (formula 1) and the solving of equations from formulæ (3) and (4) shows the line amperage so divided that .85 ampere passes through the line and 1.15 amperes pass through the instrument. Accordingly, the magnet receives a current of 1.75 volts and 1.15 amperes, which is sufficient. But, should twelve such instruments be connected to similar sections of the line, the resistance would be reduced 1.15 ohms for each section and 13.8 ohms for the twelve sections giving the line a resistance of only 41.2 ohms and a current increased to almost 3 amperes (formula 1). The point is that the shunting in of too many instruments on a 2 ampere system would raise the amperage beyond the safe carrying capacity of the wire. The danger in this case is eliminated by using 3 or 4 instruments only, which can be operated across 8 or 10 ohms of resistance. Thus two parallel 32-candle-power lamps connected in series with 10 ohms of wire will furnish about 2 amperes and will operate instrument circuits of 1.5 or more ohms. Several such systems are required for large classes and the total amperage supply is necessarily high.

Figuring with greater amperages on a single line, it is found that an 11-ampere line will accommodate sixty-five instruments on separate shunts and keep the rise in amperage below 15 per cent. This is easily determined: on a 10-ohm line carrying 11 amperes, let there be between two points *A* and *B* a potential of 2 volts and a resistance of .18 ohm, each ohm having a drop of 11 volts. With a 1.5 ohm instrument shunted in, there is found a resistance of .16 ohm (differing by .02 ohm from the original .18 ohm), a potential of 1.76 volts, and a current through the instrument of 1.2 amperes. Sixty-five instruments averaging 1.5 ohms each, even when shunted in simultaneously on separate sections, give a total reduction of 1.3 ohms, and leaving 8.7 ohms in the line allow the passage of 12.6-ampere current, which is an increase of 15 per cent. above the normal. But, as less than twenty machines ordinarily are operating at any instant, there can be a resistance not reduced more than .4 ohm, a current not greater than 11.5 amperes and hence an amperage rise not over 5 per cent.

Third, Resistor Used.—Most of the electricity passing through a line is transformed into heat energy and the temperature of the conductor rises until the heat generated by the current equals the heat dispersed per unit of time. This heat rise, other things being equal, varies to a large degree inversely with the amount of radiating surface, which again is determined by the size, length and resistivity of the wire as well as its actual resistance. A large heat rise reduces the radiating surface necessary, and for a short wire a high resistivity must be used. For a moderate heat rise as 150° F. the radiating surface becomes proportionately larger and a correspondingly moderate resistivity is demanded on a short line carrying 5 or more amperes. Comparative resistances of resistors range between 1 and 65 times that of copper. For a 2 ampere system ordinary carbon lamps and any wire of high resistance as B. & S. No. 18 "Nichrome" is satisfactory. In the "Multiple Unit" system, which, carrying 11 amperes, has 10 ohms of resistance and is allowed an arbitrary heat rise of 160° F., the resistivity for a line made as short as possible for compactness is found to be about twenty times that of copper. As an example No. 15 B. & S. 18 per cent. German silver wire 19 times as

resistant as copper and carrying 11 amperes will give a heat rise of about 160° F. The length is less than 200 feet. In selecting wire for conditions other than those given above, the different wire capacity tables may be consulted for various heat rises, lengths, etc., that are easily obtained from wire manufacturers. The choice will lie mainly with iron, 18 per cent. and 28 per cent. German silver, "climax" and nickel-chromium wires or their equivalents given under various trade names. Their resistances are, respectively, seven, twenty, thirty, fifty and sixty times that of copper.

Fourth, Unit System Installed.—The "individual unit" system, as previously mentioned, carrying 2 amperes, is applicable for a limited number of certain instruments, particularly those of higher resistance. Several such systems are necessary for class work. Jackson's[2] "single unit" system consists essentially of one large frame over which is strung the resistance line, and has a capacity for a large number of instruments. This has in general all the favorable points of the shunt rheocord system, but the chief drawback is that such a frame is situated at one place from which all tapping wires must lead. In class work this may incur confusion in identifying individual tappings, and more especially necessitates the running of an excessive amount of wire from the frame to each table. Further, it is desirable that each machine, particularly inductoria, has its own separate connection to the resistance board in order that its operating current may be varied at will and may not be affected by the working of any other instrument, as is the case when one or more are placed in parallel with it. The "multiple unit" system eliminates this objection to the "single unit" by dividing the latter into several sectional units connected in series and placing one section near each table. Confusion is avoided, extensive wiring unnecessary, and quick variations of currents to individual instruments readily made.

Fifth, Miscellaneous Details.—In general, these are for convenience and safety and concerned with electrical rules and regulations. The main leads and the wires connecting the sectional units should be insulated copper large enough to carry the desired current (B. & S. No. 16—6 amperes, No. 14—12 amperes and No. 12—15 amperes). All connections are thoroughly fastened or spliced and soldered if necessary.

Sectional or individual units may be constructed to suit individual preferences, the only requirement being proper insulation of the bare wire. Stringing the resistance line over wooden frames, even asbestos lined, is not always advisable because of possible dangers from accidental overheating. Slabs of slate or stone are more preferable since they permit ample insulation and protection. The resistant units in the author's "multiple unit" system are slate slabs 14 in. x 12 in. x 1 in. in size with a ¼-in. beveled edge, a ¼-in. hole near each corner for fastening unit to the wall being separated from it by 2-in. porcelain spools. One inch in along each long side a row of holes is drilled to fit 3/16 in. stove bolts, the holes being ¾ in. apart and so located that the wire when strung shall run in a zigzag manner. Through the holes bolts are inserted from the rear surface; a washer is placed on each next to the slate on the front surface; and the wire is strung tightly from bolt to bolt, each of which is finally tightened by a single washer and nut. The bolt ends should project out free ½ in. so that spring clips of the tapping wires may be easily attached where direct wire tapping is less convenient or not desired. Wire strands between bolts are 10 in. long and each strand produces approximately a .5-volt drop in the current. Thus a 2-volt drop is obtained across four strands. If tappings are to be made from the bolt ends only, the resistance wire may be coiled spirally, thus shortening the span of the strands and materially diminishing the size of the units.

Tapping wires are twisted flexible lamp cord of ten or other convenient length with ends numbered and all lightly soldered to prevent the strands from breaking and with spring clips, fastened to one pair of ends, for attaching to the bolt ends or the resistance wire.

[2] Jackson, *Journal A. M. A.*, 1912, Vol. LVIII, p. 1011.

Into the tapping wires between the spring clips and instrument connections ½ or 1 ampere fuses, which "blow out" with 1½ to 2½ amperes of current, may be inserted. Provision is made for connecting in series one or, in some tapping sets, two instruments.

The system may be briefly described as follows: The "multiple unit" system, used in the pharmacology laboratory of the Northwestern University Medical School consists of 8 sectional units, connected in series, strung with 10 ohms of No. 15 B. & S. German silver 18 per cent. nickel alloy wire about 200 feet long. The 110-volt, 11-ampere current enters at the positive main, passes through a cartridge fuse and switch on an enclosed switchboard, to resistance unit No. 1, to unit No. 2, so on consecutively to unit No. 8, and back through the switch and a fuse to the negative main. A pilot light is connected in parallel across some unit to indicate when current passes through the line. From varying points on any unit, double-fused flexible lamp cord may be led off to an inductorium. Similarly, a signal magnet, or an inductorium with a signal magnet in series, may be connected. Each strand is 10 in. long and has a .5-volt potential. Single instruments operate across a 3 or 4 strand shunt (1.5 to 2 volts), two instruments in series operate across a 4 to 6 strand shunt (2 to 3 volts). All instrument circuits take .5 to 1.5 amperes, according to their resistance, while during the passage of the current the voltage drops from .05 to .3 volt, due to the decreased resistance across the shunt. It is wise to test each instrument, because of possible differences in its resistance, with the volt-meter and the ammeter before using it in regular work. The "multiple unit" system is likewise admirably adapted not only for tissue stimulation with the direct current as previously mentioned, but also for physiologic chemical work as the determination of copper in sugar analysis, etc. The cost of such an outfit will range between 5 and 15 dollars, including units, switch box, wire and tapping cords. Since the operating expense is but a few cents per hour and the "system" is a permanent fixture, the actual expense is much less than that of dry batteries, which must be frequently renewed.

A few possible dangers are to be remembered. If the negative main be connected to the ground, as occurs with some power plants, "grounding" of the positive main from any point along the resistance line may take place through a tapping wire, either directly by contact with water pipes, radiators, etc., or indirectly through instruments not insulated from stands which themselves are grounded. In either case the grounding wire and any instrument in series with it takes part of the line current which usually burns out the small fuses in the tapping wire but, if not, may be so large as to injure the instrument. Signal magnets, if not insulated, may "short circuit" by permitting the current to flow from one instrument to another, either through a common stand rod, or through metal writing levers touching a kymograph drum not covered with tracing paper. This will prevent the passage of sufficient current through the instruments which then do not work properly. With a 2-ampere system for 3 to 4 instrument capacity, only the last 8 or 10 ohms of the wire nearest the negative main should be used. This, as well as the fusing of the individual tapping wires, minimizes the danger. Likewise, it is preferable if possible to have instruments operated on the negative side of a larger ampere line in order to reduce the seriousness of grounding. Students should be given the following instructions to prevent these occurrences.

First, *always* make sure that the line has no possible "ground" before the main current is switched on.

Second, tap *last* from a resistance unit when setting up an apparatus and disconnect *first* from the unit when changing instruments or through using apparatus.

Third, *insulate* signal magnets and other electrical apparatus from metal stands by heavy rubber tubing and keep tracing paper on drums which are in contact with metal writing levers.

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SCIENCE

FRIDAY, OCTOBER 23, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SCIENCE AND PRACTISE[1]

THE Society of Naturalists at this meeting celebrates its thirtieth anniversary, an occasion which in itself perhaps calls for no special felicitation, but one on which we should all rejoice on account of the safe passing of a crisis in its life. Not many years ago its very existence was threatened, and now the society finds itself securely established for a definite purpose. Conceived by its founders as a means to bring together workers in biology for the discussion of topics of common interest, it was confronted almost at the outset by a condition in which there appeared to be no such topics, so rapidly did the organization of more special societies from its midst take place. It seemed as if its career were to be that of the ephemerid, a sacrifice to its own fecundity. Ultimately, however, as a result of an experiment suggested by the late Professor Penhallow, when president of the society, a process of regeneration took place, not an exact restitution of all that had been lost by autotomy, but rather a sort of heteromorphic growth, which, while preserving the old shell, transformed the main functional activity of the organism to a new sphere, specialized but nevertheless having much common ground of interest. It is particularly appropriate that the society should have taken up the field of genetics as its own, for what has its career been but one long persistent effort in practical eugenics? Though its early experiences did seem to resemble a self-destroying schizogony, we now look upon

[1] Address of the president of the American Society of Naturalists, Philadelphia, 1913.

them as the more usual type of parenthood. Its offspring have become many and waxed strong. The eldest daughters have begun to reproduce their kind and just to-day the society rejoices in the advent of a new grandchild.[2] We can see long vistas of new physiological associations reaching out into the dim and distant future, and no one can predict where this propagation of societies will end. We view this with equanimity so long as the new organizations do not become too narrow in their interests and so long as they continue to recognize the mutual benefits of regular family reunions. From this year's gathering the society notes with regret the absence of some of its most fancied children.

Through its relationship to the affiliated societies the Society of Naturalists has now come to represent in a general way the interests of biological science. It is important that there should be some such body in existence even if it were solely for the maintenance of the proper relationship between our science and the public.

In these days of intense practical activity and social unrest it is difficult to overestimate the need for the application of science to every-day life and to the sudden exigencies of our social organization. I do not mean merely the application of science to industry or to physical health, but rather the more general relation of science to human aspirations and to human conduct.

Man to-day, while still retaining instincts which he shares with other animals, is distinguished from them by the vast modifications which accumulated experience has brought about. Social, moral and religious sanctions are so interwoven with instinctive impulses that it is all but impossible to distinguish between what is nature and what is nurture in our make-up. Yet this is the fundamental criterion for all action that seeks to improve mankind either through breeding a better race or through the modification of his behavior.

Human civilization has its many visible signs in the machinery it employs and in the objects it collects about it. These are the outward expressions of the mental and moral impulses that have actuated man and which we collectively call culture. Many definitions of this elusive spirit have been attempted, but I like best Matthew Arnold's characterization, that culture has its origin in the love of perfection, and involves two main elements—the passion for knowledge and the will to do good. It rests upon right thinking as well as upon right doing—I like this conception because it recognizes culture as creative, and not merely as passive appreciation.

> To give these forces [of culture] names from the two races of men who have supplied the most signal and splendid manifestation of them, we may call them respectively the forces of Hebraism and Hellenism. Hebraism and Hellenism—between these two points of influence moves our world. At one time it feels more powerfully the attraction of one of them, at another time of the other; and it ought to be, though it never is, evenly and happily balanced betwen them. . . . The governing idea of Hellenism is *spontaneity of consciousness;* that of Hebraism, *strictness of conscience.*[3]

Science, like literature, art and other instruments of culture, has fallen under both of these influences. Yet science in its last analysis is the very embodiment of the Hellenic spirit—the passion to know. Its great intellectual achievements are the fruition of this ideal. The application of these to the alleviation of human misery and the uplift of the world are manifestations of the spirit of Hebraism.

The commonest and the most distorted

[2] The American Society for Experimental Pathology.

[3] "Culture and Anarchy," pp. 110 and 113.

view of the value of science finds utterance in the glorification of its relation to mechanical invention and industry in general. I am not one of those who believe that science has been sullied by this alliance, but I do wish to emphasize the one-sidedness of this point of view. These improvements are applications of science. They have given us much comfort and ease, and they have suggested some of the most interesting fields for purely scientific study though, on the other hand, they have brought in their wake some of the most difficult problems with which society is confronted. However, it is not the material benefits that man now most needs. In these days when most perplexing questions are crowding upon us, it is not so much the results of science as it is the spirit of scientific inquiry and the application of scientific method that are indispensable. To have an array of investigators covering all fields of human knowledge is not sufficient. What is most needed is that the scientific spirit should permeate much further into the rank and file of humanity, that there should be a more general appreciation of the value of science beyond what it does for our bodily comfort.

It is not necessary to dwell at length upon what constitutes the spirit of science and what its methods are. Accuracy in observing and recording natural events is the very foundation of its existence; power of analysis, sense of proportion of values, and imagination are necessary for its highest achievements. The watchword of science is fair play and fearlessness in recognizing that the rules of the game are inexorable and that any infraction of them leads sooner or later to disaster. It is too much to expect the man in the street to possess scientific imagination and subtle analytic power, but it is not beyond reason to hope that there may be found in him ultimately a greater regard for accuracy and fair play in forming opinions to guide his conduct.

Modern life is, however, not satisfied with opinions—we have them to satiety. It demands action as well as words. This restless demand for action reveals undiscriminating and half-baked opinions, and it leads to one individual demanding that others make their own conduct conform to what he thinks is right.

We are just now in a period of exuberant Hebraism. At least at the present time the Hebraic ideal seems to be the dominant if not the only uplifting force opposing the most sordid materialism. But we need more light—we are in sad need of the genius of Hellenism in general affairs. It is the part of science to breathe this spirit, to provide the basis of action that is right and to discourage doing for the mere sake of doing. If, though, practical life has too much of Hebraism, the very best of science is too much without it. Scientific men must take greater part in the affairs of the world, not only in industry, but also in the idealistic movements of society. The unrelenting abomination of sham, hypocrisy and wilful ignorance which inheres in science means far more for mankind than the solution of particular problems. Who, for instance, would place the chief value of astronomy in its application to the art of navigation, to surveying, or to the prognostication of the weather, rather than in what it has done in widening man's horizon and giving right appreciation of the relation of himself and the earth to the universe? The sublime ideas of infinity of space and time and the beauty of the simple laws of planetary motion have had a value to mankind far transcending that of any so-called practical application of stellar science. The theory of evolution is in the eyes of the mul-

titude a totally unpractical idea. Yet it has done more to stir the foundations of society than the steam-engine or the telegraph.

The failure of scientific men to exert their full measure of influence in affairs rests largely upon their guilelessness and naiveté in dealing with men as well as upon their natural reluctance to express opinions on subjects about which they feel they know but little, especially since the problems involved are usually of far greater complexity than those encountered in their regular work. You will see that I am overcoming that reluctance this evening.

Society, maintaining itself upon an incomplete knowledge, which is always in process of growing, must necessarily at times receive rude shocks and make new adjustments. Just at present all its constants seem to have become independent variables. Old traditions have given way and doing is preferred to thinking. To be called a man of action is to receive the highest approbation of one's fellow-men. Yet there never was an age when there was greater need for sound thinking.

The pressing problems all involve in their last analysis the relation of the individual to society. In how far shall liberty of the individual be subordinated to that of the community? For better or for worse the doctrine of *laissez-faire* is in abeyance. It is the abuses of individual liberty that are uppermost in men's minds, and the defense of individual rights is in danger of being left completely in the hands of those who would use them for selfish ends. The spirit of social and moral progress is ground between the upper millstone of doctrinaire reform and the nether millstone of commercialism. Many good and wise men find themselves in a dilemma from which there seems to be no way out.

The more purely economic and administrative problems need perhaps cause no great misgiving. They are likely to keep themselves adjusted to the requirements of the nation even though sharp clashes of interest do arise, for here there are more exact measures of value and a sort of self-regulating mechanism which, while it may often get out of order, nevertheless will not fail entirely. It is for the social and moral questions that solutions seem most remote and the direction of travel most uncertain.

In this age of militant reform the list of measures proposed for the regeneration of mankind and for which organized propaganda is made is a very formidable one. Effort is correspondingly scattered and really important movements are befogged in a cloud of petty and oft ill-advised attempts at correction. Reformers are good citizens with the best of intentions and are frequently the sole influence for good in a community. The evils which they combat are often very serious, so that one hesitates to do or say anything in opposition to their aims, or even to the means they employ to realize them. Yet there are weighty and by no means selfish considerations that may constrain one at times to raise a dissenting voice and draw attention to some of their misdirected efforts.

The chief characteristic of reform is the dominance of Hebraism over Hellenism—"the preference of doing to thinking." It is always ready to act, and to act with enthusiasm according to what it supposes to be light, though half the time remaining blind to the need of more knowledge and neglecting the means of obtaining it. There is neither breadth of view nor sense of the proportionate value of things.

Particularly misguided are those reforms that seek to enforce by legal enact-

ment various forms of abstinence, that empty sort of moral felicity the real virtue of which consists in the circumstance that it may be followed later by some properly regulated and supposedly innocuous indulgence. The prohibition movement is the best to consider here by way of example because it is one of great force and one that aims to combat a serious evil. Any argument that is valid against it will hold *a fortiori* against similar movements.

The misery caused by drink, with all its hygienic, economic and moral phases, appeals dramatically to man's sympathy and awakens the desire to do something to mitigate it. To accomplish this no means would seem simpler and more direct than the prohibition of the sale of liquor by law. The results of this method have not been satisfactory, however, except perhaps in small communities, because the habits of mankind involved are treated merely as so many physical obstacles to be thrust aside by a calculated amount of force. It is not reasonable to expect that a large minority—within a fraction of fifty per cent. in the state of Maine—will submit to the regulation of their personal habits by scarcely more numerous neighbors. Not having the moral support of a large enough proportion of the population, the laws are violated to a scandalous degree. Thus, while the intent of the prohibition laws constitutes an unjust infringement of individual rights, their failure to accomplish their purpose, which is inevitable, is responsible for evils far more fundamental and more insidious than the drink habit itself. This is realized by a great many thoughtful persons but, incredible as it may seem, opposition to the propaganda of prohibition is left largely to those pecuniarily interested in keeping the liquor traffic intact. There are certainly some most exasperating and disheartening aspects of the liquor situation in this country—so many, in fact, that worthy citizens sit in their clubs and drink, at the same time giving a long list of reasons why they vote "no license." Nevertheless a large proportion of these evil features could readily be eradicated if we had less of that hypocrisy and cynical contempt for the law that is engendered by the existence of so many laws not really in accordance with public opinion. The experience of other countries amply justifies this view.

The methods employed to obtain prohibition legislation are often more objectionable than the measures themselves. Public opinion is aroused by protracted campaigns led by paid agitators, where enthusiasm for the cause precludes all consideration for opposing views and the rights of the minority. The legislative chambers become invaded by a veritable lobby of political and moral intimidation, and the final passage of an act is made the occasion of scenes that belong to the time of the crusades rather than to the present. Even the halls of the national congress are not exempt from such spectacles,[4] and yet those who believe that important questions should be settled with full knowledge and in a fair and dispassionate spirit stand aside and leave the opposing ground to the brewery and the saloon. To tolerate such methods for accomplishing even the most worthy purpose constitutes the gravest kind of danger to our political and social organization. The pernicious habit once acquired will surely be used for baser ends. The art of exhortation is confined neither to the righteous nor to the wise, and much, if not all, of what is done by the revivalist method will inevitably be regretted in the light of reason and have to be undone—often with difficulty.

To attempt to stop drinking by legal

[4] December 11, 1913.

compulsion is to overlook that behind the tangible evils of drink there lies a weakness of human character. It is but the part of foresight to look to influences that strengthen self-control rather than to remove some particular temptation. The latter action substitutes the restraint from without for the far more ennobling and enduring restraint from within. Man is too much of an imitator not to have his individual character deeply modified by environmental influences. The force of a good and cheerful example will accomplish more than preaching and artificial restraint. All can not be saved, but it were better that some go to the wall than that all sicken in that stifling air of virtue by act of legislature.

Almost daily some new "crusade" is chronicled. Some are directed against real evils, others are trivial and still others vicious. These reform movements, so far as they seek to regulate the private life of individuals, show weaknesses of the same kind as those just cited and probably none of them has the justification that the drink evil affords. More sound thought and less hasty action is needed. Let there be less running to the legislature for laws that make new crimes of venial offences, and laws that extend the definition of serious crimes to include lesser transgressions. Undue severity of punishment, instead of stopping crime and immorality, merely brings the law into discredit. "If we inquire into the cause of all human corruptions," wrote Montesquieu in "The Spirit of Laws," "we shall find that they proceed from the impunity of criminals, and not from the moderation of punishments. Let us follow nature, who has given shame to man for his scourge; and let the heaviest part of the punishment be the infamy attending it."[5] If this be true for major crimes, and the Romans at least found that it was, how much more does it hold for those very natural offences against good behavior that moral zealots seek to punish with severe penalties. But, I fear, such wisdom is a long way off from general recognition in this country, for, as Mr. Bryce pertinently remarks, "For crotchet-mongers as well as for intriguers there is no such paradise as the lobby of a state legislature." Lest this seem far away from science, remember that the method of science is based on experience. Shall we throw all past experience to the winds in our mad dash for the millennium?

[5] *Op. cit.*, Vol. 1, p. 96. Nugent's translation.

The youngest reform movement, as yet but scarcely born, the one which all biologists must be watching with parental solicitude, is eugenics. But this youngster, too, needs protection from its overzealous friends. Already the enthusiasts are demanding legislation, unmindful of how little information we really have to base it on, and oblivious of the vast complications of a problem which touches the very vitals of our social and our animal organization. For the present the practical application of eugenics to man would best be left to that minority of thoughtful and rather unimpulsive persons who are willing to experiment upon themselves and their descendants. On the other hand, we need not look upon the widest extension of this practise with any misgiving. The eugenic sanction, even if it does require the subordination of the impulse of the moment to future expectations, is far less artificial than many of the restraints imposed by our present social conventions.[6] In considering the motives that may impel mankind in the future to more general practise of eugenics, it does not seem likely that young men and wo-

[6] Havelock Ellis, "The Task of Social Hygiene."

men will be carried away to any extent by a higher sense of duty toward remote posterity. The ideal will be realized rather through the due appreciation of a fragment of ancient wisdom: "The father of the righteous shall greatly rejoice; and he that begetteth a wise child shall have joy of him"—Hellenic sense from a Hebraic source.

Holding the view that many of the tendencies of the time may best be combated by more general use of the methods of science, and by less worship of material results, it is pertinent to inquire how to make the scientific attitude of mind more prevalent. Here the immediate problem is not one of eugenics. Even for the present generation and the one following it we hope to do something through individual training.

Our own time has witnessed the extensive introduction of science teaching into the schools and there are now no important institutions of collegiate rank in this country where science is not at least on an equality with the humanities. As a consequence of this we should expect more satisfactory results than have been obtained. The fault is that in our science teaching too much stress is laid upon the mere imparting of information, in response to the demand that subjects must be presented in an attractive and entertaining way, and in disregard of the fact that the chief value of science lies in its methods and its spirit. We do not make enough of methods and thoroughness. School and college science is much too desultory; there is no practise in that power of sustained thought that is so necessary to the drawing of right conclusions. In the schools there are possibly difficulties in the way of concentration of studies, but it is by no means so in the colleges, and such concentration is at present hindered only by the time-worn notion that culture consists in knowing a little about everything. Specialization has been forced upon us by an unprecedented activity in all branches of learning. Not to plan our curriculum in accordance with this condition is futile. If we want men who can direct their attention to the solution of the large problems of life we must give our youths practise in concentration of thought—some rigorous schooling in the methods of reasoning by which problems are solved. One who has had such training, no matter in what subject, will have no difficulty in picking up any information he may need, but the man who has scattered his efforts will ever flounder hopelessly and will find his appetite for sound learning dulled by his persistent nibbling.

This leads to the general question of the value of discipline, a feature of training sadly lacking in our American life. We indulge our children at home, we demand no mark of respect from them, we give way in deference to all their whims, and we are pleased to see them entertained rather than instructed and trained in our schools; and on top of all of this unwise and unfitting early training it is sought to reform the world by laws that require the most self-denying conduct. Are we not trying to "teach the old dogs new tricks" —an impossibility known to the world long before the study of animal behavior became a science? Could not infinitely more be accomplished by a rigorous early training? Good habits acquired in early life would surely obviate the ground for much of that clamor for compulsion at a period of life when compulsion comes hard.

If our educational system and our family training do not altogether measure up to their opportunities in bringing more of the scientific spirit into life, what shall we say of the relations of our agents of

publicity to the problem? If the masses are not reached in the schools they may be reached through the newspaper, but at present the relation of science to the press is in a lamentable state. Especially in this country, where we pride ourselves on the freedom, the enterprise and the versatility of the daily newspaper, the relation is particularly unsatisfying to scientific men, and altogether ineffective as a means of properly interesting and informing the public on scientific progress. Probably the fault lies on both sides. The press, in catering to the popular taste for the sensational and in disregarding the very foundation of scientific inquiry, which is accuracy, utterly fails to reflect the purpose and the results of scientific activity. On the other hand, men of science hold themselves aloof, and do not appreciate their opportunity to exert a useful influence. It may be that the latter is the real root of the evil. In any case, it is at this end of the line that we ourselves may best try to help out. It is true that the limited experience which members of our profession have had in the matter of newspaper publicity does not lend much encouragement to the hope of a satisfactory outcome. Some of the most influential dailies avowedly have the desire to promote the true interests of science in relation to the public welfare; they have the confidence of some scientific men, and often have direct access to the sources of discovery, but what one of us can be satisfied with the form in which new discoveries are reported? We can not, of course, expect statements of our work to command the attention of the public if couched in the language of the *Jahresbericht*. Explanatory matter must be given, but beyond the demand of a diseased taste for the sensational, is there any necessity for the form in which science is now presented in the newspapers? Must a discovery, in order to attract notice, necessarily be heralded in flaring headlines as the greatest of the day and be accompanied by a full-page portrait of the discoverer? Yet that is the kind of science given to the newspaper-reading public to quench its thirst for knowledge.

Each year there are held in this country, not to speak of the world at large, numerous scientific congresses, at which much is communicated that is of the utmost importance to civilization. We should expect to find the proceedings adequately and decently reported in the newspapers. That this expectation is vain, is, however, obvious. To relate a little experience of my own will serve to answer why it is so. A few minutes before being called upon to speak at a medical congress not long ago, I was approached by a reporter who asked for an account of my paper. My remonstrance that he could soon hear what was to be said to the assembly, evoked the reply that he hadn't time for that and, besides, he wouldn't be able to understand if he had. Immediately after the meeting another reporter came up and asked me to explain the papers that had been read, and particularly what was meant by the terms "tissue," "cell" and "heart-beat," confessing frankly that he hadn't understood a word of what had been said.

Clearly there is no reason to find fault with either of these men for their ignorance. They may have been quite competent in their regular work. They certainly had the virtues of frankness and of knowing their own limitations. It would be unreasonable to blame a reporter of sporting or police news for a lack of knowledge of radio-activity or experimental embryology, but what should we say of otherwise resourceful newspapers that send such men to report scientific news for a knowledge-craving and credu-

lous public? That such subjects can be sensibly and accurately reported in the daily press is proved by the splendid record of the London *Times*, as shown, for instance, in its admirable reports of the last International Medical Congress. These reports have almost the accuracy that one would expect to find in official proceedings of the meetings. It is clear that the meetings were reported by experts, not only possessed of requisite knowledge, but also highly skilled in the art of writing. Here is an example worthy of emulation, and a splendid opportunity for some of our best papers to serve the public interest.

We read the newspapers and furthermore we believe what we read more than we are willing to admit, though we damn them and sneer at them at the same time. But it is wrong to say that conditions are hopeless and incapable of betterment. Improvement in the relations between science and the press can be effected through closer contact and understanding. Scientific men must emerge occasionally from the sanctum and endeavor to make their aims and their work understood. The press for its part must in reporting science give up catering to the public demand for the sensational, and allow itself to be inoculated by the germs of accuracy and honesty that give life to the scientific spirit. The scientific man must not be pictured as an alchemist in medieval surroundings, searching for the elixir of life or the philosopher's stone. He is both human and modern, and the public will learn to appreciate him sooner as a man than as a magician. The habit set by reporting science in the spirit of science would ultimately spread to the more usual fields of newspaper activity and lead to more accuracy and less desire simply to make a good story in reporting news. This and a more rational conception of what science stands for and what its methods are will give to the average man the power to view his own problems with sanity and clearness and discredit a large measure of the cant that now gains many followers.

In giving expression to belief in the signal importance of the scientific spirit for practical life we come inevitably to those questions which every one has asked and no one has answered. Whither is it all leading, and how is it going to satisfy our human yearnings? It has been often said, and correctly, that we, the philosopher-scientists of to-day, have but traveled as did the poet-astronomer eight hundred years ago.

> And many a Knot unravell'd by the road;
> But not the Master-Knot of Human Fate.

But need this observation in its modern application be interpreted as a wail of pessimism? I think not. Though modern science has not pretended and does not now pretend to have unraveled the master-knot, though its philosophy even shows that we can not hope to attain that goal, the unraveling of knots by the road has shown no tendency to stop and new ones are ever appearing, no matter how far we go. Every knot unraveled effects some change in the relation of man to his environment, and sooner or later calls for some act of re-adjustment on his part. In this respect the modern relation of science to practise seems to differ fundamentally from that which obtained during the period of Hindu and of Greek ascendency, and this circumstance leaves ground for hope that the civilization based upon it may long endure and escape the fate of its forerunners so well described in Huxley's words:[7]

> The Vedas and the Homeric epos set before us a world of rich and vigorous life, full of joyous fighting men
>
> "That ever with a frolic welcome took
> The thunder and the sunshine. . . ."

[7] "Evolution and Ethics."

and who were ready to brave the very Gods themselves when their blood was up. A few centuries pass away, and under the influence of civilization the descendants of these men are "sicklied o'er with the pale cast of thought"—frank pessimists or, at best, make-believe optimists. The courage of the warlike stock may be as hardly tried as before, perhaps more hardly, but the enemy is self. The hero has become a monk. The man of action is replaced by the quietist, whose highest aspiration is to be the passive instrument of the Divine Reason. By the Tiber, as by the Ganges, ethical man admits that the cosmos is too strong for him; and, destroying every bond which ties him to it by ascetic discipline, he seeks salvation in absolute renunciation.

In our present culture the passion to know and the finding of new knowledge calls forth the desire to act even though the two impulses are not always found in the same individual. The very technique of modern science requires action; ideas are followed by experiments and experiments give new ideas. Discoveries lead to inventions which revolutionize social and economic conditions. On the other hand, practical instruments have suggested some of the grandest ideas of science, as when the problem of the economy of the steam engine led to the discovery of the law of the conservation of energy; and who will set any limit to the flow of ideas set free by present social and industrial conditions? Thought and action are in an infinite alternate succession. Because of this, because of the relation of present science to every phase of life—physical, intellectual, economic, social, ethical—I believe that the love of right thinking will not endanger our will to act.

Nor is there grave danger in the determinism of science, which has proved to be such an effective weapon in the pursuit of knowledge. Present methods of investigation become impossible if not based upon the postulate of the "uniformity of nature," but, at the same time, the motive to carry out our inquiries, the passion for knowing, takes us ever to new and untrodden fields, broader and of ever increasing interest. This enormous unknown region, which renders the prediction of the remote future but idle fancy, and hems our ability to predict our own conduct even in commonplace affairs, leads us to ascribe to ourselves freedom to act as we will, and to place upon individuals a proper share of praise and blame for their acts. This feeling, which is instinctive, will not generally give way unless the time should come when all of the events of nature can be foretold with precision.

It is not my wish to indulge in the pastime of prophecy. The tendencies of the time, though in reality but ripples, may often seem like mountainous waves about to engulf all. We may consider ourselves fortunate if we can see over the crest of the nearest wave and apply our strength and skill to stem its force. The present danger is not a wave of individualism and anarchy; it is rather a perversion of moral and intellectual ideals that seeks to confine spontaneity and individuality within a pale of external restraint, to minister to all wants, to regulate all joys—in other words, to *standardize* human character, by smoothing out to monotonous level those ups and downs of life that make us what we are.

Thinking and doing are for the time out of balance. Science has the power to restore and maintain the balance by breathing more of its spirit into practical life, and if an instrument to guide this work is needed—if it is right for men of science to have a confession of faith—I know of none more inspiring than the words that Huxley used in defining his own life purpose:

To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of

life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

Ross G. Harrison

PUBLIC HEALTH EDUCATION, WITH SPECIAL REFERENCE TO THE SCHOOL FOR HEALTH OFFICERS OF HARVARD UNIVERSITY AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY[1]

From time immemorial the world has recognized three great professions—the ministry, law, medicine. They stand, respectively, for love, order and health—the great trinity upon which human happiness is founded. During the nineteenth century another profession arose, different from the other three in that it concerns itself with things external, but nevertheless of vast importance to the well being of the race—the profession of engineering. With many parts, heterogeneous, amorphous, the world has not always recognized it as a united whole; but gradually it has become crystallized around the central idea that "engineering is the application of the great forces of nature for the use and convenience of man." Thus our professional triangle has become four square and our modern civilization may be said to rest upon the four learned professions—the ministry, law, medicine, engineering.

Between these corner posts of education the framing of our social structure is intimate and complex. Beams stretch from one post to the other, and there are braces and cross-braces; combinations of sciences, sub-professions and vocations. As civilization becomes more complex the network thickens until we can scarcely recognize the boundaries of our callings and even our avocations become mixed with our vocations.

[1] Address delivered at the New York State Conference of Sanitary Officers at Saratoga, N. Y., Sept. 15, 1914.

Every once in a while some particular need of the race comes prominently to the front, and as the need becomes filled and men educate themselves for it we say a new profession has come—meaning a new species, not a genus.

At the present time the great need of the world is *peace*. The new science of engineering has built one of its structures too high and it has toppled over. Over-developed armaments have thrown the nations into a sea of blood, from which only the other three professions can rescue them, those which stand for love, order and health. But it is not civil engineering which has wrecked Europe, it is military engineering—the application of the great forces of nature not for the use and convenience of man but for the destruction of man. This is not what is meant when we speak of the new fourth great profession.

Although engineering has failed to blot out war, it has done much to blot out the other great scourges of the race—famine and pestilence. The development of transportation on land and sea has brought the wheat fields of the smiling prairie to the parched desert, and has widened the market gardens of the city. Agricultural engineering has multiplied the fruits of the soil. The development of cold storage has widened our markets in time as well as distance. Future famines from natural causes will occur only when engineering fails to do its work.

In combating pestilence the profession of engineering has combined with that of medicine. When disease comes from without it requires the aid of a profession which deals with things external, and as disease always acts within it requires the aid of a profession which deals with things internal. It is idle to discuss whether the doctor or the engineer plays the greater part in preventing disease. Where so much has been accomplished by both, where the work to be done is so great, there are tasks enough and rewards enough for both professions. In fact we must include the professions of ministry and law because social service and legal force are potent weapons in the campaign for health. Let us recognize as our first principle that the leaders in this cam-

paign, the health officers of the country, must base their work upon all four of the great professions, upon medicine, engineering, law and social service. It is for this ideal that the new School for Health Officers of Harvard University and the Massachusetts Institute of Technology stands and it is about this ideal that I wish to speak to you to-day.

The movement for fostering health and preventing premature death from accident and disease is world wide in its range, and has attained a magnificent popular momentum, thanks to thousands of earnest men and women who have approached the subject from many different angles. It is a mighty stream, and like a mighty stream has power for good and power for harm. It needs to be controlled. The movement needs to be organized through regularly constituted governmental agencies. The mechanism for this already exists in crude and diversified forms. We have departments of health in most states and cities, local boards of health in small communities, occasional county or district organizations, voluntary associations, philanthropic agencies, and last but not least our ambitious and constantly improving national Public Health Service. Without in any way belittling what is being done, on the contrary with a just pride in what has been accomplished, we must all admit that, take it the country through, the public health service is ineffectively organized and insufficiently supported. The need of the hour is for official leadership and for the public recognition of this need for official leadership.

We are all familiar with the term "captains of industry." We know that the men so called are leaders in the industrial world. But we also know that industrial organization would go to smash were it not for the sergeants of industry and for the corporals of industry, for those who come into actual contact with the rank and file of business men. Similarly we have our "captains of health." Their great names are known to us all. We recognize their ability. When they speak the world listens and takes heed. But as an organization we lack the sergeants of health and the corporals of health, we lack the local leaders.

Our present local health officers have risen from the ranks, generally from the medical profession. All honor to those who have served so faithfully and so well. Those who have succeeded and have become not only sergeants, but captains of health, have done so only by long service, individual study and personal sacrifice. Individuals here and there have succeeded, yet the method is wrong.

Our present service is unequal in efficiency. The large city, with a large problem, can afford to pay a large salary to a large man. The small town with a small problem has likewise been obliged to pay a small salary to a small man, or, to put it less harshly, to pay a small salary to some man who, because of the small salary, can not give all of his time or thought to the public health service. We also have local boards of health where no one is paid, and where the service is consequently irresponsible. A great fault is that the ultimate unit has been too small. The problem of caring for a people's health is so complicated that the man who attempts it should not try to do anything else. He can not do so in justice to himself and to his work.

In order that he may give his whole time to his job he must be paid a living wage. And in order that he may be paid a living wage he must serve a district large enough to afford such payment. Hence the ultimate unit must be made larger than it has been in the past. Improvements in transportation and the communication of thought make this possible to-day to a much greater extent than formerly. The town, or the borough, or the village, or the small city will not ordinarily prove adequate, and one of the signs of the times is the establishment of public health districts presided over by a district health officer. The state of New York has adopted this system and Massachusetts is following her example.

We also have in Massachusetts examples of voluntary combinations of neighboring towns to secure the services of a health officer who

gives his full time to the towns included in the arrangement. The towns have the advantage of the services of a specialist and the man receives joint compensation commensurate with his services.

The first step in perfecting our public health organization, therefore is to provide for full time health officers, serving districts large enough to afford an adequate salary for a well-trained man.

The second step is that of securing stability of service, by establishing long terms for health officers. To train one's self for this work costs time and money. It requires capital in the shape of education and experience. No man can afford to enter upon this career unless his livelihood is assured. Furthermore, a health officer's success does not depend wholly upon his knowledge of sanitary principles; it depends equally upon his knowledge of the community. He must know his territory geographically and physically, and he must know his people and their habits of life. This knowledge can be acquired only by familiarity.

The third step is coordination. Lines of authority should be established from the health officials of the smallest communities through the districts to the state departments of health, which in some states are already well organized. Cooperation between the states under the general direction of the federal government will also be necessary.

But let us come now to the man himself. What shall the health officer be, a doctor, an engineer, a lawyer, a minister? Yes, any one of these, provided he knows enough about the other three professions and has the proper personality. Instances may be cited where lawyers and where ministers have become public health officers, and in recent years many engineers have proved conspicuously successful in this field. It must be admitted, however, that in the majority of cases men have entered this service through the profession of medicine. This was natural and proper as long as disease was regarded as something wholly personal, and it probably will remain true that for many years to come the best portal of entry to the public health service will be that of the profession of medicine. By this is meant that the man already learned in medicine will have less to learn of the other sciences than he who is already trained in some other profession will have to learn of matters that are biological and medical. Again, the world has for so long regarded the medical practitioner as the custodian of the public health that the title of doctor carries with it a certain prestige which is of advantage from an administrative point of view.

We have seen, however, that the profession of public health has greatly broadened. Young men starting afresh for this career can not afford in most cases to become a doctor of medicine first and a doctor of public health afterwards, or an engineer first and a doctor of medicine afterwards. Also the training for the degree of M.D. contains many matters which relate to healing and have practically nothing to do with the prevention of disease. The time devoted to them can be spent to better advantage in the study of other subjects more directly connected with public health administration, such as sanitary engineering and demography.

It is a fatal mistake, therefore, to make the medical degree a prerequisite to public health positions, as it tends to disbar from the service young men who are giving themselves the broadest and best possible education for the positions that need to be filled. Some of our best and most recent laws still contain provisions for this outgrown and unfortunate limitation. The requirement of an M.D. was doubtless made in order to safeguard the service from the political appointment of unfit men, but it now needs modification in order to provide for the new conditions and to admit to the service those who are specializing in preventive medicine and the control of the public health. It is true that the harm will come in the future rather than at present, but it is the future of the service to which we should look. Laws which prescribe an M.D. degree should be amended by the addition of some such modifying clause as this—"A doctor of medicine or a person trained in public

health holding a degree or certificate in public health from a school of recognized standing." This would open the field of service to those best qualified to serve and would at the same time prevent the unscrupulous political appointment of unqualified persons.

There is an increasing number of young men who without an M.D. degree are fitting themselves for public health service. What is more they include some of the best of the college graduates, men who have come to realize that they can best serve humanity by helping to maintain humanity's health, men who are going to devote their lives to the cause. The states and cities which remove the present disbarment will get the services of these enthusiastic progressive specialists and will benefit accordingly.

Before the field of service in the public health is fully opened to men without the medical degree it is right and proper that the training which students are getting in the acquirement of a degree or certificate in public health be carefully examined to see if it is adequate. Unless the training is adequate the change in the laws should not be made. I bring before you to-day the program of studies at the School for Health Officers of Harvard University and the Massachusetts Institute of Technology—the first school of its kind in the country, trusting that it will be studied and that we may have the benefit of advice founded on experience.

The School for Health Officers is conducted by Harvard University and the Massachusetts Institute of Technology, acting in cooperation, through an administrative board appointed for this purpose, by both institutions. At the present time the board consists of Professor William T. Sedgwick, chairman, Professor Milton J. Rosenau and Professor George C. Whipple. It is significant of the spirit of the school that these men are respectively a doctor of science, a doctor of medicine and a civil engineer. Dr. Rosenau is director of the school, with headquarters at Harvard Medical School.

The principal object of the school is to prepare young men for public health work of all kinds and especially to fit them to occupy administrative and executive positions, as health officers, or members of boards of health, or secretaries, agents or inspectors of health organizations. To this end, lectures, laboratory work and other forms of instruction are offered by both institutions, and by special instructors from national, state and local health agencies. The subjects embraced in the course of study have been selected to cover a wide range, including medical, biological, hygienic and engineering sciences, together with practical health administration.

A certificate in public health (C.P.H.) is granted to candidates who have satisfactorily completed the studies in an approved schedule, who have spent not less than one academic year in residence, and who have otherwise complied with all requirements. This certificate is issued by Harvard University and the Massachusetts Institute of Technology and signed by the presidents of both institutions. The first class graduated in June, 1914, when five men received their certificates. It happened that all of these had previously received a medical degree. The membership in the school is now eleven.

The question may naturally occur to some one, why call this a certificate in public health, and not a doctor of public health, or a diploma in public health. The reason is that the degree of Dr.P.H. is already administered by Harvard University in its medical school, and stands for a larger body of work, and a longer course than most men can afford to take or than it is necessary to take in preparation for many of the positions in the public health service. The reason that the "Diploma in Public Health," *i. e.*, D.P.H. was not chosen was because these letters sometimes stand for doctor of public health and our school desired to avoid giving what might appear to be a doctor's degree, but technically was not.

The following are the requirements for admission: Graduates in Medicine of Harvard University and other recognized medical schools are admitted upon their records and registered as candidates for the certificate in public health. Bachelors of science in biology

and public health of the Massachusetts Institute of Technology and other recognized institutions are likewise admitted and registered as candidates for the certificate.

Masters of civil engineering of Harvard University who have specialized in sanitary engineering and bachelors of science in sanitary engineering of the Massachusetts Institute of Technology and other recognized institutions, who lack the necessary preparation in medical and other sciences, are admitted upon their records, but are required to spend at least one year in preparation before being accepted as candidates for the certificate in public health.

Other graduates of colleges or technical or scientific schools are admitted to the school without examination, provided their collegiate courses have included adequate instruction in physics, chemistry, biology, French and German; but, as a rule, they are required to spend two or more years in preparation before being accepted as candidates for the certificate in public health. Applications for admission to the school will be considered from those who have spent at least two years in a recognized college or technical or scientific school and have pursued satisfactory courses in physics, chemistry, biology, French and German, and also from persons of unusual experience or special qualifications; but, as a rule, such persons are required to spend two or more years in preparation before being admitted as candidates for the certificate.

Special students, not candidates for the certificate in public health, who desire to fit themselves for some special field are admitted to the school, and may take any course or courses for which they are properly qualified, on approval of the administrative board.

Women are admitted to the School for Health Officers on the same terms as men, and are equally eligible for the certificate in public health. Women are admitted to many of the courses given in the Harvard Graduate School of Medicine, but not to undergraduate courses in the Harvard Medical School. If women require the latter courses they must be obtained elsewhere, preferably before entering the School for Health Officers.

As the school is now in its infancy no uniform curriculum is required of candidates for the certificate in public health. Each student is required to choose a schedule of courses to meet his individual needs. In general, the choice of studies must be such that the candidate on the completion of his course will have covered in a broad way the subjects included in the varied duties of a public health officer, together with such allied subjects as anatomy, physiology, pathology, biological chemistry, sanitary biology, preventive medicine and hygiene, demography and sanitary engineering.

After a few years' experience it is probable that some standard curriculum will be prescribed, but the time for this has not yet arrived, as the qualifications of the average student on entrance remain to be learned. It is probable also that different standard schedules will be made for students who wish to prepare for different fields of work.

Every candidate for the certificate in public health is required to complete satisfactorily each course taken by him and, on the completion of his approved schedule, to submit to a general oral examination by the administrative board. This examination covers not only his work in the school, but his previous studies and experiences. Last year the oral examination of each student lasted at least two hours.

The courses available in the school are not restricted to those stated in the catalogue of the school, but may include subjects in any department of Harvard University or the Massachusetts Institute of Technology, provided the work is in harmony with the objects of the school and meets with the approval of the instructor in charge of the course and of the administrative board. Certain special courses are given by instructors not otherwise connected with either institution, and practical work may be taken in city, state and national health departments and in the hospitals of Boston. As time goes on it is the intention to increase the opportunities for this practical work, or apprenticeship, which obviously is an

important element in a health officers' training.

The courses offered are divided into two lists. The first is a list of so-called regular courses, which demand considerable time and ordinarily cover a half year or more. It is from this list that the student is required to make his principal selection and do his most serious work. The second is a list of special courses and lectures.

The courses are also divided into eight groups according to subject. These groups are as follows:

1. Preventive Medicine.
2. Personal Hygiene.
3. Public Health Administration.
4. Sanitary Biology and Sanitary Chemistry.
5. Special Pathology.
6. Communicable Diseases.
7. Sanitary Engineering.
8. Demography (Vital Statistics).

The following is a list of the courses offered in 1914:

REGULAR COURSES

Group I. Preventive Medicine

Principles of Sanitary Science and Public Health. Professors W. T. Sedgwick and S. M. Gunn.

Preventive Medicine and Hygiene. Professor M. J. Rosenau, Dr. L. W. Hackett, Dr. E. S. Birge and Dr. F. B. Grinnell.

Public Health Problems. Professor S. M. Gunn.

Epidemiology. Professor W. T. Sedgwick.

Relation of Animal Diseases to the Public Health. Professor Theobald Smith and Dr. Carlon Ten-Broeck.

Tropical Medicine. Professor R. P. Strong.

Group II. Personal Hygiene

Personal Hygiene. Professor W. B. Cannon.

Personal Hygiene. Professor P. G. Stiles.

Industrial Hygiene and Sanitation. Professor S. M. Gunn.

Group III. Public Health Administration

Practical Health Administration. Dr. M. W. Richardson, Dr. W. C. Hanson and Mr. H. C. Lythgoe.

Sanitary Law. Professors W. T. Sedgwick, S. C. Prescott, R. S. Weston and S. M. Gunn.

Municipal Sanitation. Professor S. M. Gunn, Mr. R. N. Hoyt.

Sanitation of Houses and Public Buildings. Professor S. M. Gunn.

Public Health Administration. Professor S. M. Gunn and Mr. R. N. Hoyt.

Hygiene of Ventilation and Heating. Professor W. T. Sedgwick.

Group IV. Sanitary Biology and Sanitary Chemistry

Protozoology. Professors Theobald Smith and E. E. Tyzzer.

Entomology. Professor W. M. Wheeler and Asst. Professor C. T. Brues.

Advanced Bacteriology. Dr. E. C. Howe.

Bacteriology of Tropical Diseases. Professors H. C. Ernst and S. B. Wolbach and Dr. Austin.

Dairy Bacteriology. Professor S. C. Prescott.

Bacteriology of Water and Sewage. Professor S. C. Prescott.

Zoology and Parasitology. Professor R. P. Bigelow.

Helminthology. Dr. Philip E. Garrison.

Sanitary Biology. Dr. J. W. M. Bunker.

Analysis of Water, Sewage and Air. Dr. J. W. M. Bunker.

Water and Air Analysis. Dr. J. F. Norton.

Water Supplies and Waste Disposal. Dr. J. F. Norton.

Food Analysis. Professor A. G. Woodman.

Advanced Food Analysis. Professor A. G. Woodman.

Group V. Special Pathology

Comparative Pathology of Tropical Diseases. Professor Theobald Smith.

Pathology of Tropical Diseases. Professor F. B. Mallory.

Clinical Laboratory Work. Professors H. C. Ernst and S. B. Wolbach and Dr. Austin.

Group VI. Communicable Diseases

Communicable Diseases. Dr. E. H. Place.

Communicable Diseases (Interneship at South Department, Boston City Hospital). Dr. E. H. Place.

Biology of Infectious Diseases. Professor S. M. Gunn.

Board of Health Diagnosis. Dr. F. H. Slack.

Public Health Laboratory Methods. Professor S. M. Gunn and Associates.

The Diagnosis of Rabies and Glanders by Laboratory Methods. Dr. Langdon Frothingham and Dr. E. F. Walsh.

Group VII. Sanitary Engineering

Sanitary Engineering. Professor G. C. Whipple and Assistants.

Sanitary Engineering—Summer Course. Professor G. C. Whipple and Assistants.

Water Supply Engineering. Professor G. C. Whipple.

Sewerage Engineering. Professor G. C. Whipple.

Limnology. Professor G. C. Whipple, Dr. J. W. M. Bunker and Assistants.

Sanitary Research Laboratory. Mr. M. C. Whipple.

Rural Sanitation. Dr. J. W. M. Bunker.

Hydraulic and Sanitary Engineering. Professor Dwight Porter.

Advanced Hydraulic and Sanitary Engineering. Professor Dwight Porter.

Engineering of Water and Sewage Purification. Professor Dwight Porter.

Theory and Practise of Water and Sewage Purification. Professor R. S. Weston.

Group VIII. Demography

Demography. Professor G. C. Whipple and Assistants.

Sanitary Biometrics. Professor S. M. Gunn.

Vital and Sanitary Statistics. Professor D. R. Dewey.

SPECIAL COURSES AND LECTURES

Group I. Preventive Medicine

Infant Mortality. Professor J. L. Morse.

Genetics and Eugenics. Professor W. E. Castle.

Social Service Work. Professor R. C. Cabot and Miss Ida Cannon.

Tropical Dermatology. Professor R. P. Strong and Dr. H. P. Towle.

Group II. Personal Hygiene

School Hygiene. Dr. T. F. Harrington.

Mental Hygiene. Professor E. E. Southard and Associates.

Venereal Prophylaxis. Professor E. H. Nichols.

Tropical Sunlight. Professor Theodore Lyman.

Posture and Deformities. Professor R. W. Lovett.

Ocular Hygiene. Dr. F. H. Verhoeff.

Oral Prophylaxis. Professor W. H. Potter.

Prevention of Diseases of the Ear. Dr. H. P. Mosher.

Group III. Public Health Administration

Sanitary Law—Legal Powers of Health Officers. Professor Eugene Wambaugh.

Medical Inspection of Immigrants. Dr. M. V. Safford.

Municipal Sanitation. Dr. C. V. Chapin.

Group IV. Sanitary Biology and Sanitary Chemistry

Venomous Animals. Dr. Thomas Barbour.

Poisonous Plants of the Tropics. Professor W. J. V. Osterhout.

Climatology. Professor R. DeC. Ward.

Group VI. Communicable Diseases

Tuberculosis. Dr. J. B. Hawes, 2d.

Group IX. Medical and Other Sciences

The following courses are also open to students registered in the School for Health Officers:

At Harvard Medical School:
- Anatomy, gross and microscopical.
- Embryology.
- Physiology.
- Biological Chemistry.
- Pathology.
- Bacteriology.

At the Massachusetts Institute of Technology:
- General Bacteriology. Professor S. G. Prescott.
- General Physiology. Professor P. G. Stiles.
- Physiological Laboratory. Dr. E. C. Howe.
- Vertebrate Anatomy. Professor R. P. Bigelow.

At Harvard University:
- Elementary Bacteriology. Dr. J. W. M. Bunker.

This intellectual bill of fare is not as complicated as it looks, but the long list of courses shows the opportunities offered by the educational institutions in Boston for students of public health. In fact, the resources of one of the oldest and best medical schools and the first great engineering school of the country are available, and to these should be added the opportunities presented for cooperation with the Massachusetts State Board of Health, the Board of Health of the City of Boston, the various hospitals in the city, and the excellent medical and engineering libraries.

It is not the food which is put upon the table, but that which is eaten and digested, which nourishes. It is not what the student has opportunity to learn, but what he does

learn that counts. And perhaps the best thing to be said about the new School for Health Officers is that it is a combination of schools which have been noted for efficient instruction and for the hard work done by the students. The Harvard motto "Veritas" is combined with the Institute motto "Mens et manus"—mind and hand working together for the truth, or truth expressing itself through mind and hand. We believe that the spirit which has created these two institutions will not fail to build up a school of public health which will faithfully serve its day and generation.

But lest I be accused of screwing the nut too tightly upon Boston as the hub of the universe let me say that we who shelter ourselves beneath the fins of the codfish do not claim to have a monopoly of the sea. What has most impressed us in making our plans has been not the magnificence of our Boston institutions, but the magnitude of the problem which the country has to solve—the problem of ministering to the health of a hundred million people gathered from all the quarters of the globe.

In conclusion, let me restate the ideal for which the School for Health Officers of Harvard University and the Massachusetts Institute of Technology stands—for a body of educated sanitarians working in many fields and well-trained for their particular work—but especially for the health officer whose education is based on all four of the great professions—medicine, engineering, law and social service. And it calls to the states and cities and towns of the country and says, "This is the kind of a man you need to protect your public health, a man broadly trained and well-paid who can afford to give all his time and all of the best that is in him to the work." It calls to the legislators and says, "Amend your laws so that you can get this kind of men." It calls to the young men of the country and says, "The field is ripe for the harvest." And it calls to the other universities and says, "Join us in this great movement to secure men for the public health service." Let us all work together for the health of the country and the health of the world.

George C. Whipple
Harvard University

SCIENTIFIC NOTES AND NEWS

Among the thirty-seven honorary degrees conferred on the occasion of the one hundred and fiftieth anniversary of the founding of Brown University were two doctorates of science, given to Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, and Dr. L. A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institution.

At the celebration of the twenty-fifth anniversary of the Johns Hopkins Hospital a portrait of Sir William Osler, by Mr. Sargeant, was presented.

Mr. Douglas W. Freshfield, known for his publications on mountains and other subjects, has been elected president of the Royal Geographical Society.

Professors Roentgen, Lenard and Behring have each recently been reported to have repudiated the gold medals conferred on them by scientific associations in Great Britain, and have donated them to the Red Cross or other relief work, and now it is said that the Hanbury medal has likewise been donated for relief work by its recipient, Dr. E. Schmidt, professor of pharmacology at Marburg.

Dr. George H. Whipple, a graduate in 1900 of Yale and M.D. in 1905 of Johns Hopkins, and since 1906 a member of the faculty of the department of pathology of Johns Hopkins Medical School, has taken up his new duties as director of the George Williams Hooper Foundation for Medical Research, to endow which Mrs. Sophronia T. Hooper of San Francisco recently gave to the University of California property valued at much more than a million dollars. Three other appointments have been made to the foundation. Dr. Karl Friedrich Meyer and Dr. Ernest Linwood are to become associate professors of tropical medicine, and Dr. Charles W. Hooper is to be fellow in research medicine. The head-

quarters of the foundation will be in special laboratories at the University of California Medical School buildings on Parnassus Avenue, San Francisco.

Dr. Benjamin White, formerly director of the department of bacteriology of the Hoagland Laboratory, Brooklyn, is now assistant director of bacteriological laboratories of the department of health, New York City, and is in charge of the research and antitoxin laboratories at Otisville, and Dr. Harold Lyall, formerly associate director of the department of bacteriology of the Hoagland Laboratory, is now bacteriologist at the Otisville laboratories.

Dr. S. Morgulis has been placed in charge of an investigation of the metabolism of fish by the Bureau of Fisheries of Washington, D. C. The investigation is being conducted in the New York Aquarium and in the biochemical laboratory of the College of Physicians and Surgeons, Columbia University.

Dr. W. J. Dilling, of Aberdeen, has been appointed to the newly established "Robert Pollok" lectureship, for research in materia medica and pharmacology, at the University of Glasgow.

Professor Albert Perry Brigham has returned to Colgate University after spending the past year in Europe. In August he gave a course of seven lectures before the Oxford University school of geography, on "Regional development and conservation problems in the United States."

Mr. Leo E. Miller, of the Roosevelt expedition to South America, has completed plans for another expedition. He will leave New York within a few days for Porto Columbia, where he will begin his trip of exploration in the interest of the American Museum of Natural History. The expedition is supported by a gift of $5,000 from Mr. Roosevelt.

News has been received from Professor William M. Davis, formerly head of the Harvard geological department, who after the meeting of the British Association visited in late August and early September the Great Barrier reefs of the Queensland coast of northeastern Australia, and on September 11 sailed from Sydney via New Zealand to the Society Islands, where he expected to spend a month examining Tahiti and other members of that group. He expects to return to Cambridge early in November.

President Harry Pratt Judson, who has been absent for six months from the University of Chicago in the prosecution of his duties as chairman of the China Medical Commission of the Rockefeller Foundation, sailed from Yokohama, Japan, September 29 on the Pacific Mail Steamship *Mongolia*.

Professor Horatio H. Newman, of the department of zoology in the University of Chicago, will give before the College Endowment Association of Milwaukee, Wisconsin, a series of four lectures on the general subject of "The Social Life of Animal Communities." He will discuss in the opening lecture parental care, mutual aid, and social life among animals. In the second lecture will be considered community life among bees and wasps, and recent discoveries concerning their habits and intelligence. In the third lecture he will discuss ant communities, their agriculture, armies, battles, and slavery; and in the last, the most complex insect communities—termites or white ants.

Miss Ellen B. Scripps has made a gift of $35,000 (in addition to $60,000 previously subscribed by herself) for a pier, pumping plant and additional equipment for the Scripps Institution for Biological Research, at La Jolla, near San Diego, California. For its maintenance she gives yearly to the University of California $10,000.

The annual meeting of the Association of American Universities will be held at Princeton on November 6 and 7.

The annual meeting of the Society of American Bacteriologists will be held in Philadelphia, December 29, 30 and 31, 1914, under the presidency of Professor Charles E. Marshall. The session programs will be arranged as follows:

Tuesday, A.M. Systematic Bacteriology, H. A. Harding, Urbana, Ill.

Tuesday, P.M. Technique, G. F. Ruediger, La Salle, Ill.

Wednesday, A.M. Industrial Bacteriology, R. E. Buchanan, Ames, Iowa.

Wednesday, P.M. Sanitary Bacteriology.

Thursday, A.M. Infection and Immunity, J. A. Kolmer, Medical Dep't University of Pennsylvania, Philadelphia, Pa.

Thursday, P.M. Ventilation, C.-E. A. Winslow, 25 West 45th Street, New York City, N. Y.

On Thursday afternoon the session will be devoted to a symposium on Ventilation with Section K of the American Association for the Advancement of Science. Professor C.-E. A. Winslow has this program in charge. The local committee of arrangements consists of D. H. Bergey, Jos. Leidy, Jr., Jos. McFarland and A. Parker Hitchens, chairman. The secretary is A. Parker Hitchens, Glenolden, Pa.

The eminent French physicist, Professor Ch. Fabry, of the Faculté des Sciences, Marseilles, is devoting himself to radiography for the benefit of the wounded in the war. He fears an exhaustion of the French supply of X-ray tubes and has written to an American friend, requesting that makers and dealers in such supplies should communicate with him at once, giving prices of their supplies and tubes for medical and surgical purposes.

"Mendel's Vererbungstheorien aus dem Englischen übersetzt von alma Winckler mit einem Begleitwort von R von Wettstein." Teubner, Leipzig, 1914, is a German edition of Dr. W. Bateson's well-known book recently reviewed in these columns. It will be useful to those who read German more readily than English, or by preference.

Dr. Henry Chandler Cowles, associate professor of plant ecology in the University of Chicago, was engaged some time ago by the United States Department of Justice to make an investigation of a large tract of timber land in Arkansas which had been originally surveyed as lake. Professor Cowles's services as an ecological expert were secured to determine from the nature of the timber and other evidence whether or not the area could possibly have been lake as recently as the time of the original survey in 1847. The investigation was made and testimony given, and the United States judge of that district gave a sweeping decision in favor of the government's contention. Among the findings was that none of the areas returned as lake had any evidence of a beach line such as should have existed. But the most striking evidence of the fraudulency of the original survey was the existence of immense upland trees growing over all the areas, many of the trees being from two hundred to three hundred years old, and some of them from five hundred to a thousand.

"The Production of Explosives in the United States during the Calendar Year 1913" has just been published by the United States Bureau of Mines. The total production of explosives, according to the figures received from manufacturers, was 463,514,881 pounds (231,757 short tons), as compared with 489,393,131 pounds (244,696 short tons), for 1912. This production is segregated as follows: black powder, 194,146,747 pounds; "high" explosives other than permissible explosives, 241,682,364 pounds, and permissible explosives, 27,685,770 pounds. These figures represent a decrease of 36,146,622 pounds of black powder and an increase of 7,212,872 pounds of high explosives and 3,055,500 pounds of permissible explosives. As explosives are essential to mining, and the use of improved types of explosives lessens the dangers of mining, the Bureau of Mines undertook the compilation of information showing the total amount of explosives manufactured and used in the United States, its first report dealing with the year 1912. This is the second technical paper relating solely to the production of explosives that the bureau has issued. It is expected that similar publications will be compiled annually, and that with the cooperation of the manufacturers these statements will be published within a few weeks after the end of each year. The figures show that in 1902 only 11,300 pounds of permissible explosives was used in coal mining, whereas in 1913 the quantity so used was 21,804,285 pounds. The quantity of permissible explosives used in the United States is larger than in a number of foreign countries. In 1912 it represented about five per cent. of the total quantity of explosives produced, and in 1913 six per cent. The total

amount of explosives used for the production of coal in 1913 was 209,352,938 pounds, of which about ten per cent. was of the permissible class as compared with eight per cent. in 1912. The use of permissible explosives in coal mining has had gratifying results, and few, if any, serious accidents can be attributed directly to their use.

The consumption of white arsenic in the United States in 1913 amounted to about 7,200 tons, valued at $570,000, of which 2,513 tons, valued at $159,236, was produced in this country as a by-product from copper and precious-metal smelters, and the remainder was imported largely from European countries. For the present imports of arsenic will probably be seriously diminished and the American smelters can save much more arsenic than they do now, for the cheapness of the product has prevented the saving of all that was practicable. Works for the exclusive production of arsenic have been erected at only two places in the United States—Brinton, Va., and Mineral, Wash. It is difficult for such plants to produce arsenic to be sold in competition with the by-product of the smelters except in periods of high prices, such as may again prevail if the industrial disturbances are long continued.

The value of the mineral production of the United States now exceeds $2,500,000,000 a year, according to the United States Geological Survey. Though this value falls far below that of the country's farm products, the magnitude and scope of our mineral industry may be best measured by comparing our own mineral production with that of other countries, no one of which can compete with us in abundance or variety of mineral resources. The United States mines nearly 40 per cent. of the world's output of coal and produced 65 per cent. of the petroleum in 1913. Of the more essential metals, 40 per cent. of the world's output of iron ore is raised from American mines, and the smelters of the United States furnish the world with 55 per cent. of its copper and at least 30 per cent. of its lead and zinc. These are the raw materials on which has been founded a great metallurgical industry, but on which can be built much more extensive chemical and metal-working industries.

According to statistics recently completed by Ernest F. Burchard, of the United States Geological Survey, the production and shipments of iron ore in the United States exceeded those of any previous year. The crude iron ore mined in the United States in 1913 amounted to 61,980,437 long tons, compared with 55,150,147 tons mined in 1912—an increase of 6,830,290 tons, or 12.38 per cent. The iron ore shipped from the mines in the United States in 1913 amounted to 59,643,098 long tons, valued at $130,905,558, compared with 57,017,614 long tons, valued at $107,050,153, marketed in 1912—an increase in quantity of 2,2625,484 long tons, or 4.60 per cent., and in value of $23,855,405 or 22.28 per cent. The average price of ore per ton for the whole country in 1913 was $2.19, compared with $1.88 in 1912. These quantities of ore, both mined and marketed, include the iron ore used for fluxing other metallic ores at smelters in the Middle and Western states, but do not include the iron ore sold for the manufacture of paint. The iron ore marketed for paint in 1913 amounted to 16,950 long tons, valued at $44,851. The ore reported as sold for fluxing purposes other than in the manufacture of pig iron amounted to 62,842 long tons, valued at $235,588, in 1913, compared with 88,449 long tons, valued at $244,315, in 1912. The domestic iron ore actually marketed for the manufacture of pig iron amounted in 1913 to 59,580,256 long tons, valued at $130,669,970, compared with 56,929,165 long tons, valued at $106,805,838, in 1912. Iron ore was mined in 28 states in 1913, one more than in 1912. Idaho, Montana and Nevada produced ores for fluxing only; part of Colorado's output was used for fluxing and part for pig iron; a little magnetic ore mined in Utah was shipped to a Salt Lake iron foundry for testing a new method of reduction, and the remainder of the Utah ore was used for fluxing. The other states produced iron ore for blast-furnace use only, except small quantities for paint from Georgia, Michigan, New York and Wis-

consin, which are, however, excluded from the above figures for iron ore. The rank of the five states producing the largest quantity of iron ore—Minnesota, Michigan, Alabama, New York and Wisconsin—remained unchanged in 1913, but there were a few changes in the relative rank of certain of the smaller producers. The Minnesota iron ranges are yielding at present considerably more iron ore than is produced in all the rest of the states together, having furnished 62.37 per cent. of the total for the United States in 1913. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 52,377,362 tons in 1913, or 84.51 per cent. of the total.

UNIVERSITY AND EDUCATIONAL NEWS

Phillips Academy, Andover, Mass., receives a bequest of about $462,000 under the will of Melville C. Day, of New York, who died in Florence, Italy. This amount is the residue of the estate. At the termination of a life estate created for the benefit of a friend, Phillips Andover will receive a further sum of about $45,000.

Frederick William Dohrmann, for a number of years a regent of the University of California, has bequeathed $5,000 as a loan fund, for loans to members of the faculty to tide them over hard places in times of illness or other emergency.

Brown University celebrated last week the one hundred and fiftieth anniversary of its foundation. Among the events were historical addresses by Dr. W. W. Keen, of Philadelphia, and the Hon. Charles E. Hughes, of the Supreme Court. Dr. William Peterson, principal of McGill University, gave the university address. Thirty-seven honorary degrees were conferred, the recipients including the presidents of the seven universities established before Brown. There were many academic exercises and entertainments.

The University of Louvain has accepted the offer of the Cambridge University to give the use of its libraries, laboratories and lecture rooms during the present crisis, without the payment of the usual fees, in order that the work of the Belgian University as a corporate body may be carried on without breach of continuity. Cambridge University has only 1,500 students, as against 3,500 last year, and other institutions have lost students in about the same proportion. The German universities expect about one third the usual attendance.

The last year of the post-graduate course of the Naval Academy at Annapolis is now taken at the school of engineering at Columbia University and seventeen lieutenants and one ensign, in active service in the U. S. Navy, are in attendance. Under the naval regulations the course is of two years, and both were taken at Annapolis until last year. It was decided, however, that, while the instruction at the academy was feasible as far as the first year was concerned, the equipment then was not sufficient for the second year, so Columbia was chosen for the more advanced work.

The attendance at the University of Chicago for the summer quarter has been announced, and shows an advance over the registration for the corresponding quarter a year ago. The total number of men registered in the graduate schools of arts, literature and science was 860 and of women, 528, a total of 1,388; in the senior and junior colleges 572 men and 605 women, a total of 1,177; in the professional schools, divinity 282, medicine 135, law 163, education 991, making a total of 1,571; and excluding duplications, the registration for the entire university was 3,974, the largest summer registration in the history of the institution.

Cornell University Medical College opened with an enrollment as follows: For the degree of M.D., first year, 55; second year, 28; third year, 32; fourth year, 20: special students (work not leading to the degree of M.D.), 12: for the degree Ph.D., 5, making a total of 152. All students now registered, with the exception of those pursuing the combined seven years' course leading to the degrees of A.B. and M.D., are graduates of arts and sciences, or doctors

of medicine doing advanced work. Students in the combined course present the baccalaureate degree before they are admitted to the second year in medicine.

In accordance with the agreements for cooperation between the Massachusetts Institute of Technology and Harvard University, fifteen of the Harvard professors are to be added to the instructing staff of the institute this year. Their names and departments are the following:—*Mining Department:* Professors Henry Lloyd Smyth, Edward Dyer Peters, Albert Sauveur, George Sharpe Raymer, Charles Henry White and Louis Caryl Graton. *Mechanical Engineering Department:* Professors Lionel Simeon Marks and Arthur Edwin Norton. *Drawing, Civil Engineering Department:* Professors George Fillmore Swain, Lewis Jerome Johnson, Hector James Hughes and George Chandler Whipple. *Department of Electrical Engineering:* Professors Arthur Edwin Kennelly, Harry Ellsworth Clifford and Comfort Avery Adams.

At the University of Pennsylvania promotions include the following: Dr. Bradley Moore Davis, to be professor of botany; Dr. Oliver Edmunds Glen, to be professor of mathematics; Dr. Howard Hawks Mitchell, to be assistant professor of mathematics; Dr. Melvin Reece Harkins and Dr. Dicran Hadjy Kabakjian, to be assistant professors of physics; Dr. Samuel G. Barton, to be assistant professor of astronomy. Dr. Lowell J. Reed has been appointed instructor in mathematics, and Mr. E. J. Lund instructor in zoology.

At Rutgers College Professor Alfred A. Titsworth has been appointed dean of mechanical arts and Professor Jacob C. Lipman, dean of agriculture.

Dr. Alexander J. Inglis has resigned as professor of the science of teaching at Rutgers College, to become assistant professor of education in Harvard University.

George H. Chadwick, for seven years professor of geology at St. Lawrence University, is now connected with the department of geology at the University of Rochester. His successor at St. Lawrence is Dr. C. J. Sarle.

Dr. Charles Oscar Chambers has been appointed instructor in agriculture, biology and applied chemistry at the George Peabody College for Teachers. He comes from the University of Cincinnati, where he was acting head of the department of biology last year.

Dr. Paul B. Clark, of the Rockefeller Institute for Medical Research, has been appointed associate professor of bacteriology in the University of Wisconsin, succeeding Dr. Mazyck P. Ravenel, who has gone to the University of Missouri.

DISCUSSION AND CORRESPONDENCE

HEREDITY AND ENVIRONMENT

To the Editor of Science: Some discussion has been held lately in the columns of Science concerning the question of the influence of monarchs and the relations of heredity to the manifestations of statecraft and warcraft in rulers. Professor Woods has been one of the champions of the view that monarchs and their immediate kin show exceptional excellence in both these lines, and he has based his thesis on a wealth of illustration from history, that, apart from his interpretation, must command admiration as a scientific inquiry.

One point will, I think, be admitted by all who go somewhat deeply into the problem of descent, and, that is, that starting with beings of good physical and mental characteristics, inbreeding will emphasize many of these and produce a well marked and strong race. The Jews and the Irish show this fact. Both have been to a large extent close bred, due partly to religious, partly to geographic conditions. For centuries the Jew was separated from the other races by his adhering to a peculiarly exclusive religious code. The Irish—I refer, of course to the Roman Catholic Irish—were for centuries separated by island habitation, as well as intense religious antagonisms, from their nearest neighbors. Even in the melting pot—the United States—the two strains have been kept well apart from each other and from the bulk of the population. Intermarriage between Jews and Christians, or between Irish Catholics and Protestants, or even

between Irish and German Catholics are only occasional.

When, however, we come to ascertain the relative value of heredity and environment in determining the character of offspring, it seems to me that it is necessary to use extreme caution, to eliminate, on the one hand, mere coincidence, and on the other hand to avoid confusing the two influences. The development of the germ cell and the fertilizing cell we must consider heredity, but gestation is largely environment, and surely this period is of profound importance to the new being, especially in the case of human beings, with which the period is long and markedly subject to psychic influences. The period of infancy is, so far as rulers, or the highest social classes even, are concerned, a period of special environment, eminently adapted to continue and intensify any qualities distinctly marked in the parents. Monarchs' children are from their birth set apart from the world at large, surrounded by an atmosphere of authority and pretense; surely these conditions must have a large share in determining character. If one feature looms largest in the characters of rulers throughout the ages, it is their ruthlessness, that is, their indifference to the rights and feelings of their subjects. Just as the mass of children learn from their parents and associates to consider the lower animals as having no rights that human beings are bound to respect, so the young prince is taught to regard the mass of his nation.

Nor can we overlook opportunity as an element in favoring the ruler. By the very condition of things, his views prevail. In the light of modern theories, especially, the materialistic conception of history, are not many of the incidents of a given reign merely manifestations of causes within the core of humanity itself, and the monarch a creature of such causes rather than himself a cause? In other words, in ascribing to Louis XIV. a profound share of the development of France, are we not making the mistake of assigning Tenterden steeple as the cause of Goodwin Sands? "There was a man sent from God whose name was John." Is it permissible to say that there was a man sent from God whose name was Abraham Lincoln? Can any one assert that Abraham Lincoln was any more necessary to the working out of a proper destiny of this country than a hundred of the prominent statesmen, north and south, in his day? I think it has been proved by Adams in his recently published volume, that the success of the Federal forces was almost entirely due to the efficiency of the blockade of the ports of the Confederacy.

In Professor Woods's two volumes on this topic we miss a study of the influence of two important classes of rulers with whom heredity can have little concern, namely, the popes and the presidents of the United States. Chosen under more or less emotional conditions, a long line of pontiffs exhibits striking examples of human excellence and human failings. The latest, and probably the best authority, on this series—the Catholic Encyclopædia—places Gregory VII. as the greatest of them, yet by his own statement he was from the proletarian. Of recent popes, Leo XIII. is the most able; his claim for noble descent was only established with difficulty and there is no ascription to him of blood royal.

Then what is to be said of the great line of American statesmen, drawn from the lower ranks, such as Franklin, Paine, Hamilton, Jackson, Lincoln? It is admitted that the cause of American independence was furthered as much by a journeyman printer and a journeyman corset maker, as by any one.

Henry Leffmann

A FEMINIZED COCKEREL

From time to time during the last five years, grafts of various sorts have been attempted in connection with studies of the effects of castration on the domestic fowl. The condition of one of the birds on which grafts have been made is of particular interest.

A Brown Leghorn *male* was castrated completely when 24 days of age and the ovaries from two brood sisters, cut in several pieces, were placed beneath the skin and also within the abdominal cavity.

At date of writing, the bird is as obviously

a female in general appearance as its brood sisters. Several skilled poultrymen, when shown the bird, have unhesitatingly pronounced it a pullet.

Aside from a perfectly clear record, the marks of the operation, which are still visible, show that the bird when operated on must have been a male.

While possible that this particular individual may owe its feminized character to a constitutional condition, such as hen feathering, such an assumption is extremely improbable. Rather, it seems more probable that the bird has actually been feminized by the implanted ovaries in similar fashion to the rats and guinea-pigs of Steinach.

A full account of the bird will be published after it has been under observation for several months.

H. D. GOODALE
MASSACHUSETTS EXPERIMENT STATION,
AMHERST, MASS.

A THIRD ORDER RAINBOW

TO THE EDITOR OF SCIENCE: On September 11, as I stood near the lake in Beardsley Park, Bridgeport, Conn., I observed a rainbow in such an unusual position that it seems to be worthy of some short description. The rainbow was first noticed about a quarter of five in the afternoon, with the sun perhaps 60° from the zenith. The sky in general was clear, though there were heavy clouds above the eastern horizon and very light cloud streaks between the observer and the sun, with a few fleecy clouds near the zenith. No rain was falling, and probably none had fallen in the region for some time, nor was there indication that any would fall for hours; yet, between the observer and the sun, some 10° from the zenith, there appeared between two of the clouds a distinct rainbow, clearly observed by others whose attention was called to the phenomenon.

The bow was rather short, not over an eighth of a circumference, convex toward the sun, and showed plainly the usual rainbow colors. Not until the bow had faded to such an extent that the colors were no longer marked was it recalled that no accurate statement of the order of colors could be given. It is my impression now that the red was on the convex side.

Wood's "Physical Optics," second edition, p. 343, gives for the deviation produced by K internal reflections in a sphere

$$D = 2(i - r) + k(\pi - 2r)$$

and for minimum deviation,

$$\cos i = \sqrt{\frac{\mu^2 - 1}{K^2 + 2K}}.$$

For $K = 3$, this gives

$$i = 76° 50,$$
$$r = 46° 55',$$
$$D = 318° 20',$$

whence the angle between the emergent and incident light would be about 42°. This would agree fairly well with the rough estimate of 50°. Hence the conclusion that the rainbow observed was the result of three internal reflections within suspended drops of such small size and number as to give no appearance of a cloud.

Various authorities, however, state with more or less emphasis that the bows corresponding to three reflections are never seen on account of the much more intense direct light from the sun. In the case cited above it would seem that the light clouds directly between the observer and the sun served to diminish the intensity of the direct light to such an extent that the bow was plainly seen.

This seems to be the only explanation for the bow, but considering the very light clouds noted above, the observation is all the more remarkable.

H. W. FARWELL

A SOLAR HALO IN VIRGINIA

THE solar halo, a sketch of which is appended, was visible over a considerable portion of east Virginia for several hours on Sunday, November 2, 1913. It was observed by the writer at Fredericksburg, Virginia, at one P.M. on that day. The phenomenon was of the greatest brilliancy, the acessory "suns" being at times almost as brilliant as the sun itself. The great circles around the horizon were dis-

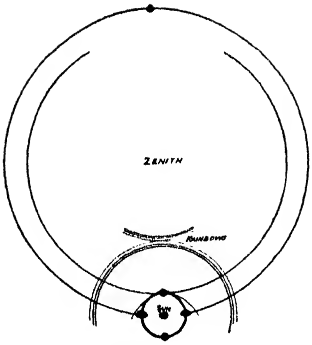

FIG. 1.

tinctly marked, and persisted for hours. The bright spot at the opposite pole from the sun was only occasionally visible. The rainbows were brilliantly colored and could be seen until the sun was almost down.

The sky at the time was almost clear, except for a few wisps of cloud and a thin haze which was densest directly over the face of the sun.

A. W. FREEMAN

SCIENTIFIC BOOKS

Photo-electricity. By H. STANLEY ALLEN. London, Longmans, Green and Co., 1913. 8vo. Pp. ix + 221. Price $2.10 net.

Photo-electricity. By ARTHUR LLEWELYN HUGHES. Cambridge, The University Press, 1914. 8vo. Pp. viii + 144.

The present generation of physicists has seen the rapid and almost spectacular development of several important fields of activity in physics: such, for example, as the subject of electric waves, of kathode rays and electrons, of X-rays, and of radioactivity. While the subject of photo-electricity has not aroused the same widespread and popular interest as the subjects just mentioned, there are at present many reasons for believing that the study of photo-electric phenomena may prove to be of almost equal importance in its bearing upon theories of atomic structure and of radiation.

I imagine that most physicists have read the paper in which Hertz described his discovery of the photo-electric effect. The paper is reprinted in Hertz's "Ausbreitung der elektrischen Kraft" and in the English translation "Electric Waves." I can think of no scientific article which illustrates so well not only what research in experimental physics ought to be, but also how the results should be presented. It is a good illustration also of the importance of the unexpected things that so frequently turn up in experimental work. It will be remembered that the discovery of the photo-electric effect came as an incident in Hertz's work on electric waves. As difficulty was experienced in seeing the minute sparks that indicated the response of the resonator, he tried to improve matters by placing a box around the gap so as to screen the eyes. But instead of making it easier to see the sparks the box apparently made the resonator less sensitive. I imagine that most of us would have been content to call the attempted improvement a failure, and would have dismissed the matter with mingled feelings of mild wonder that the scheme didn't work, and regret that we had wasted so much time in making the box. But Hertz was not content to simply wonder. He set out to discover why the box had such an unexpected effect, and by a beautifully logical series of experiments and deductions he found the answer to his question. Since it appeared that the new phenomenon had no bearing upon what he regarded as his more important problem, he left its further study to others and returned to the subject of electric waves.

Hertz's paper aroused wide-spread interest and the work was quickly taken up by others. During the first nine years after Hertz's discovery more than one hundred articles dealing with the photo-electric effect were published, and interest in the subject has continued undiminished since. As no résumé of the subject has been published which is at all complete, it is clear that the physicist who wishes to make himself familiar with what has been done in this important field has no small task before him.[1] The almost simultaneous

[1] A résumé of work on the photo-electric effect was published in SCIENCE, Vol. IV., p. 853 and p. 890, 1896, which was, I believe, complete to the time of publication. The subject has developed so greatly since that time, however, that this summary has little more than historical interest.

appearance of two books on the subject of photo-electricity is a welcome response to a very general demand.

Dr. Allen's book is intermediate in character between a popular or semipopular presentation—such as would be suitable for the reader with a general scientific interest, or for workers in subjects related to physics—and a detailed summary intended for the specialist. After two introductory chapters, giving a very brief general survey of the whole field and an account of the work of the early experimenters, the author takes up in greater detail such subjects as the emission of electrons in a vacuum, the velocity of the electrons emitted, the photo-electric behavior of different substances, the influence on photo-electric phenomena of gas-pressure, temperature and the wave-length of the exciting light, and photo-electric fatigue, to whose experimental study Dr. Allen has himself contributed. Then follow chapters on "Theories of Photo-electric Action," "Fluorescence and Phosphorescence," and "Photo-electrical Actions and Photography." Since the topics treated in the last two chapters, although probably related to the subject of photo-electricity, are not to be regarded as essential parts of the general subject, the author makes no attempt at a complete treatment of these topics.

Dr. Allen makes no attempt to summarize all the articles dealing with photo-electricity, and has not given a complete bibliography. The value of the book would have been greatly increased if a complete list of articles had been given. But even without this the book is of great value. In discussing each topic references are given to some of the more important original articles, so that the reader who wishes to go into the subject in detail will be greatly helped.

For the specialist I imagine that Dr. Hughes's book will be found the more useful of the two. It assumes considerable familiarity on the part of the reader with the subject and with related subjects, and goes into greater detail in the critical discussion of the results obtained by different observers. This is especially true in the case of those phases of the subject which are now attracting most attention. At the end of each chapter there is a summary of results, and in many cases a discussion of their theoretical bearing, which will be found very useful. References to original sources, although not complete, include most of the more important articles. In the main the ground covered is the same for the two books. Dr. Hughes includes, however, a chapter on the ionization of gases by ultraviolet light, which is looked upon as one instance of photo-electric action. There are also short chapters on positive rays produced by light, and on the sources of light used in photo-electric experiments. On the other hand the treatment of photo-electric fatigue is less complete than in Dr. Allen's book, and the subjects of luminescence and of photographic action, to which Dr. Allen devotes two chapters, are not taken up at all.

In discussing the velocity of emission of photo-electrons Dr. Hughes points out that while it seems probable that a linear relation exists between the maximum energy of the photo-electrons and the frequency of the exciting light, so that the retarding potential necessary to prevent discharge is given by $V = kn - V_0$, the constant k has not been found to have the value h/e which Einstein's theory, based on the theory of quanta, would lead us to expect. Since this chapter was written Millikan's measurements on sodium have not only established the linear relation between V and n with greater exactness and through a wider range than has been done by any previous investigation but have also led to a value of ke which differs from h by considerably less than the uncertainties in the value of Planck's constant. This chapter of Hughes's book would undoubtedly have been considerably modified if it had been written after the publication of Millikan's work. Nevertheless the author's discussion retains its value, for the results obtained by other observers still requires explanation.

I am convinced that these books will be found most useful, both by those who wish only to be informed regarding recent progress in the subject of photo-electricity and by those who are engaged in investigation in this field.

Ernest Merritt

PEARSON'S TABLES FOR STATISTICIANS AND BIOMETRICIANS

When one is told that the advance of science is in a high degree dependent upon improvements in technique, one naturally thinks of the astronomical and physical instruments of precision, the calorimeters of the chemist's equipment, the microtomes and microscopes of the general biological laboratory, and of the pure culture and surgical technique of the clinic. With such magnificent examples of instrumental facilities for research, it is easy to forget the large debt of modern science to mathematical methods of description and analysis. Even if one limits oneself to the cases in which the mathematical tools have taken the most workable form—that of tables of final constants for given value of observation or tables to facilitate the calculation of such constants—the debt is enormous. Who can estimate the service to applied science of the engineer's pocket books of formulæ and tables? or the value to pure science of the convenient volumes of logs and trigonometric functions? or, to be both specific and modern, of such volumes as the "Physikalish-chemische Tabellen" of Landolt and Börnstein, the tables for physicists and chemists of Castell-Evans, and the "Annual Tables of Constants and Numerical Data" published by the Commission of the International Congresses of Applied Chemistry?

The most recent advance of this kind is marked by the publication of a series of tables for the use of statisticians and biometricians.

With the foundation of the Biometric School of Biology, there were available only the general aids to calculation--tables of logarithms and trigonometric functions, Barlow's tables[1] and Crelle's.[2]

All of these are still to some extent useful, though the improvement of calculating machines has rendered them less indispensable.

The tables[3] before us, carefully designed as they are to meet the needs of a special group of students, are in a very different class. To workers in the difficult field of higher statistics such aids are invaluable. Their calculation and publication was, therefore, as inevitable as the steady progress of a method which brings within the grip of mathematical analysis the highly variable data of biological observation. The immediate cause for congratulation is, therefore, not that the tables have been done but that they have been done so well.

In the original prospectus of *Biometrika,* the editors promised to provide "numerical tables tending to reduce the labor of statistical arithmetic." Since 1901, when the first of these tables was published in *Biometrika,* the responsible editor has had but one end in view, the publication, as funds would permit, of as full a series of tables as possible.

A detailed list of the tables which have resulted from the grim perseverance in this determination for the past fifteen years is superfluous. Such fundamental series of constants as Sheppard's "Tables of the Probability Integral," Elderton's Tables of Values of P for Pearson's χ^2 Test of Goodness of Fit of Theory to Observation, Everitt's "Tables of the Tetrachoric Functions," Rhind's "Criteria for Frequency Types and Probable Errors of Frequency Constants," and such convenient aids to calculation as Miss Gibson's values of χ_1 and χ_2 and Soper's $1-r^2$ to lighten the labor of the calculation of the probable errors are only sample titles of the fifty-five sets calculated by Bell, Duffell, Elderton, Everitt, Gibson, Greenwood, Heron, Lee, Pearson, Rhind, Sheppard, Soper, "Student" and Whitaker, which cover with great completeness the whole field of statistical description and analysis.

The convenient volume in which these are now brought together contains something over 75 pages of explanation and illustration and

[1] Barlow's tables of squares, cubes, square roots, cube roots and reciprocals of all numbers up to 10,000. London, Spon.

[2] Dr. A. L. Crelle's calculating tables giving the products of every two members from 1 to 1000 and their application to the multiplication and division of all numbers above one thousand. Revised by C. Bremiker. New York, Steckert.

[3] "Tables for Statisticians and Biometricians." Edited by Karl Pearson, F.R.S. Issued with assistance from the grant made by the Worshipful Company of Drapers to the Biometric Laboratory, University College, London. Cambridge University Press, 1914.

about twice that space of solid tables and diagrams. It has three noteworthy characteristics.

The first is the excessive labor involved in calculation. In a few instances, for example, in the case of the tables χ_1, χ_2 and $1-r^2$ to facilitate the calculation of the probable errors, it has been possible to arrive at constants of the greatest usefulness with a minimum of simple arithmetic. But in the great majority of cases, each entry has cost heavily. It is probably safe to say that the difficulties of computation have been far greater than in the majority of published tables.

The second remarkable feature of the book is originality of contents. For the most part, volumes of tables are largely made up of old material which has long since become common property. Practically, the whole of this quarto is strictly new. In only a few cases have materials already published been better adapted to meet the needs of statisticians. Thus the tables of logarithms of the Gamma function have been adapted from those of Legendre; the table of angles, arcs and decimals of degrees is based on Hutton's mathematical tables; after the table of logarithms of factorials had been completed, similar tables issued in 1824 were discovered and used as checks.

The third distinguishing feature of the volume is that it represents the work of a single laboratory and its associates under the leadership of the one who has finally brought the colossal undertaking to completion.

The cost of publication has been very great; it has been made possible only by distributing the expense of setting and moulding over a period of years of first publication in *Biometrika*. Thus the completion of the tables has largely depended upon the possibility of maintaining *Biometrika*. Though this has been given such protection as copyright affords, it has been practically impossible to prevent piracy of tables already issued and so to make possible the completion of the series. The editor remarks with a bitterness which is fully justified by his experience of the last few years: "It is a singular phase of modern science that it steals with a plagiaristic right hand while it stabs with a critical left."

The volume is indispensable to all who are engaged in serious statistical work.

J. Arthur Harris

Crystallography. An Outline of the Geometrical Properties of Crystals. By T. L. Walker. New York, McGraw-Hill Book Co., 1914. Pp. xiv + 204, 213 figures in text.

So many elementary treatises on crystallography have appeared in the American press within the last five years that a new one would seem to be justified only by the introduction of some essentially new feature. Such a justification is certainly to be claimed for this brief work by Professor Walker in which a discussion of the geometrical properties of crystals is based on the gnomonic projection as employed in the methods of Goldschmidt.

After brief consideration of the process of crystallization in very elementary terms there is given in Chapter IV. an account of the gnomonic projection showing how by its means a graphic representation of the relations of crystal faces may be obtained; how numerical symbols for the forms and values for the axial elements may be read directly from it; and how the regular arrangement and spacing of the projection points illustrate the laws of symmetry, of constancy of crystal angles and of the rationality of parameters. The chapter also contains instructions for preparing both gnomonic and stereographic projections from two-circle goniometric measurements as well as an account of the conventional axes of reference and the derivation of Miller's index symbols.

This chapter seems to the reviewer an admirable presentation to the beginning student of the difficult subject of the mathematical relations of crystal faces. No adequate account of Goldschmidt's very useful methods exists elsewhere in the English language and these methods are here very happily welded to the conventional ones which they illuminate. It is to be regretted that the author did not supplement his account by a statement of Goldschmidt's energy theory of

the growing crystal with its simple expression in numerical symbols; and by a clear statement of the general reciprocal relation which exists between the polar elements of Goldschmidt and the linear elements of Miller.

The systematic description of crystal forms follows conventional lines, the concept of hemihedrism being used throughout to classify the various symmetry classes within each system. Chapters on twinning and on crystal drawing from gnomonic projection complete the author's text. A final chapter contains extracts from various American crystallographic publications which illustrate to the student the methods of procedure required for several varieties of crystallographic investigation. These extracts seem on the whole of doubtful value to the class of students for whom the book is primarily intended.

The illustrations include gnomonic projections of the holohedral class of each system. The crystal figures have suffered severely at the hands of the printer; a great number, nearly one third it seemed on a rapid estimate, are set skew on the page; figures 25 and 206 are inverted; and figure 161 is obscure. The text is free from such obvious results of careless proof-reading.

CHARLES PALACHE

Industrial and Commercial Geography. By J. RUSSELL SMITH. New York, Henry Holt & Co. 1913. Pp. xi + 914. 6 × 8¾ inches. Price $4.

The complex field of interests in which the student of industrial and commercial geography works, involves many matters which are not geographic, and many pitfalls are laid for the geographer who sets venturesome feet across its borders. Professor Smith has some freedom in working this field, since he comes to it as an economist, rather than as a geographer, and he has chosen "to interpret the earth in terms of its usefulness to humanity. And since the primary interest is humanity rather than parts of the earth's surface, the book deals with the human activities as affected by the earth, rather than with parts of the earth as they affect human activities." Thus the author frankly states his point of view, and as honestly does he carry it out through the 900 pages which follow. So the geographer has but one protest to make, and that is as to the choice of title. The work should have been called "A Text-book of Industry and Commerce" and it is in recognition of this point of view and purpose of the work, that this review is written.

The book is divided into two parts, Industrial Geography and Commercial Geography. In the first part there are essays on the changing forces in our environment; the place and nature of agriculture; on various industries and the commodities produced by them; on the fundamentals of manufacture; on the mineral industries and on the expansion of industries and resources. The second part of the book is given over to a statement of the principles underlying commerce; then to a sketch of the great highways of commerce, including the ocean, and trade routes of the various continents. The last four chapters are on the trade center; the balance of trade; and geographic influences in the commercial policy of nations.

The book makes interesting reading. One must admire the wealth of interacting relations presented by the author, even though he must at times take issue with the statement of fact or interpretation of the phenomena discussed. The style is frank and easy, often almost colloquial, quite unlike the usual textbook. In fact it will be criticized on this point as at times diffuse and in need of condensation.

Of course errors are bound to creep into any book. The most careful proof-reading will not avail against errors. But there are so many errors in this first edition as to make it seem that parts of it were overlooked in the proof reading. In the interest of accuracy it will be fair to call attention to some errors and inaccuracies. The author states, p. 46, that it is too cold for winter wheat north of Nebraska. Yet the record yield of wheat in America is held in eastern Montana, and with winter wheat. On p. 63 a wrong addition is made in footing up the world's wheat production; p. 75

the sense is spoiled by using run for rim; p. 92 the statement is made that corn has no gluten; p. 105 Austria is said to be in the Baltic basin; p. 106 Chile is given just one climate, the Mediterranean, and is said not to be hospitable to the potato, the country in which the potato originated; p. 119 Japan is credited with one sixth of her land under cultivation. The Japanese are much more modest in reporting the arable area; pp. 288 ff coffee, tea and cacao are treated as *condiments*; p. 292 ff San Domingo is wrongly used as the name of a country; p. 293 a wrong date is given for the abolition of slavery in Brazil; p. 296 Havre is given as the world's greatest coffee market; p. 307 diacritical marks are omitted from the Portuguese form of St. Thomas; p. 330 ff pilagic does duty for pelagic; p. 375 Maderia for Madeira; p. 378 ff the final letter is omitted from Pittsburgh; p. 378 steamboats are given credit for plying to Minneapolis; p. 403 has the great falls of Iguazu on the Parana River; p. 441 the form Austro-Hungary is used, and in another place Austro for Austria; p. 449 Estremaduro for Estramadura; p. 454 states that the Philippine forests belong to the United States government; p. 454 the Philippines are stated as "tree poor," an astonishing statement; p. 445 the tropical cedar used in making cigar boxes is said also to be used in making lead pencils; p. 498 we learn that "wool is covered with minute scales, whereas hair is smooth"; p. 584 Spain, etc., given credit as the source of most of our sulfur supply; p. 617 "plate glass . . . passed between rollers which give it the beautiful smooth surface"; p. 619 "the ancients were better artificers in copper than are the moderns"; p. 627 aluminum is said to be a more efficient "transmitter" of electricity than is copper; p. 637 a legend says "silver production is unusual in that it does not increase." The graph above the legend shows an increase from 72 to 220 in the period covered.

There are many examples of inaccuracy which may be due to loose writing. Such, for example, as p. 172, where the whole Parana valley is made a sheep district like that in Australia; p. 285 vacuum pans are used because there is *less* danger of burning; p. 311 vanilla "is an orchid-*like* vine"—but why continue? There are scores of these faults, little and big, which should not have gone out even in a first edition.

Such errors, while a serious blemish, are not permanent handicaps. Careful editing may remove them. The spirit of the author is so good, his interpretations so suggestive, that when a revision is made the book will stand as the best text-book presentation so far published in this country, of the complex and difficult field of industry and commerce, from the geographic viewpoint. The book can be used with advantage as a text in college classes, where the teacher, if a geographer, may easily accentuate to his taste the purely geographic elements involved.

J. Paul Goode

University of Chicago

THE COMMITTEE ON GENERAL SCIENCE OF THE NATIONAL EDUCATION ASSOCIATION

The returns which have come in thus far indicate that the schools should give information from the whole field of science—not neglecting astronomy. The public needs unmistakably require a new organization of science instruction according to *projects*. The problems of life are not differentiated after the manner of specialized science. Pupils in both elementary and high schools are in a much more primitive state of mind in regard to all science than our school programs would indicate. Many are apparently blind and deaf to nature's most evident teachings. They are in the depths of superstition about common things even while surcharged with academic formulas regarding things scientific. Our secondary schools persist in articulating with that which is above them rather than with the elementary school. Few persons appear to know that they have the answers to most of their questions readily accessible in dictionaries, encyclopedias and readable books. Apparently we have deprecated the teaching of science from books too long and too success-

fully. The greatest need, and likewise the greatest demand, among even highly educated persons, is for *information* rather than *training* in science. All workers and students require training in their specialty, but in other fields they want knowledge in simple form and by the most direct method.

Natural science has moved from a position of great worth as a school subject to one of minor importance. Science teachers everywhere are beginning to regard it a high duty to bring it back to its rightful place and value. Attention has been too sharply focused on teaching "subjects" as against teaching students those things that are important for them to know. The schools reached the lowest point in real science instruction when, under the stress of preparing for higher institutions, they narrowed their work to "the forty quantitative experiments." It was desultory, scrappy, unorganized, unscientific. At best the teaching was confined to vocabularies of technical words, definitions of scientific terms, statements of "fundamental principles," etc. The natural and effective order is not principles followed by applications, but the reverse. From a multitude of experiences, facts and observations, arranged so as to illuminate one another, some few principles may be derived; if these principles can be shown to be fundamental and can be brought into immediate use. The trouble with most of the so-called "fundamental principles" is that they are never again met either in school or life, and the majority even of enlightened men get on very well without having ever heard of them, or, having heard, they have forgotten them because they did not prove to be fundamental to anything. A principle which occurs, or is likely to occur, so often that one can not forget it, is fundamental, and few others need be considered.

Principles are not to be taught merely for discipline and training, nor for use only in a remote future.

The study of "projects" in science will necessitate the breaking down of boundary fences that have been erected between highly specialized sciences.

General science should be adapted to local conditions and may not be universalized. Many projects elaborated by ingenious and skilled teachers should be published in a series of small books or pamphlets for the use of pupils. Teachers may select from these as time, place and other circumstances require. Enough of this material may easily be prepared to occupy many years of study on the part of pupils. What it is worth while to know from the fields of astronomy, botany, chemistry, geology, meteorology, physics, physiology, zoology, etc., may be thus acquired.

Correspondence is invited.

John F. Woodhull,
Chairman

Columbia University,
New York City

INDIANA UNIVERSITY EXPEDITIONS TO NORTHWESTERN SOUTH AMERICA

In these columns in 1905, Dr. C. H. Eigenmann gave a discussion of the fresh-water fishes known from both slopes of Panama,[1] and suggested the advisability of a biological survey to record their distribution before the completion of the canal should furnish a waterway and allow the intermingling of the two faunas. His conclusions were, in the main, that the Pacific slope fauna was derived from the Atlantic slope fauna in times more recent than the obliteration of the interoceanic connection, and that this fauna crossed the divide somewhere near Panama. At his suggestion, resolutions were adopted by various scientific bodies, including the International Zoological Congress and the American Association for the Advancement of Science, calling upon the president and congress to provide means for a survey of the regions about the canal. In 1910, under the auspices of the Smithsonian Institution, the survey was organized from among the various scientific departments at Washington. The collection of fishes was intrusted to Dr. S. E. Meek, of the Field Museum of Natural History, and Mr. S. F. Hildebrand,

[1] Science, N. S., Vol. XXII., No. 549, 1905, p. 18.

of the U. S. Bureau of Fisheries. They spent the winters of 1910 and 1911 in the field, but their results remain largely unpublished.

In December, 1911, Professor Eigenmann left for Colombia with the principal object of investigating the faunas of the Atrato and San Juan Rivers, south of Panama. These rivers flow in opposite directions in a longitudinal trough west of the Western Cordilleras and the height of the divide between them does not much exceed 300 feet. Other points were the relation of the faunas of the Atrato and the Magdalena, which seemingly possess no obstacles to inter-migration, and the relationship existing between the faunas of the upper Cauca and the upper Magdalena, separated as they are by the high Central Cordilleras. Dr. Eigenmann landed at Cartagena and proceeded thence by river steamer and rail up the Magdalena, collecting en route at Puerto Wilches, Peñas Blancas, Honda and Girardot, thence to the high plateau of Bogota, where a large collection was made of all fishes occurring there, including the supposedly mutating "capitan" (*Eremophilus mutisii*). He then proceeded by pack-train from Girardot through Ibagué and Toche, crossing the Central Cordilleras over the Quindío pass, descending thence to the Cauca at Cartago, from which point he continued by pack-train to Cali, collecting on the way. With more pack mules the Western Cordilleras were crossed to Caldas; from here collections were made at successively lower elevations on the River Dagua to the coast at Buenaventura. From this point a steamer carried the expedition up the San Juan to the head of navigation at Puerto Negria, thence a dugout continued on to Istmina. The low continental divide was crossed here to the Atrato; he went then by steamer to Cartagena. Collections were made at various points along these rivers. Dr. Eigenmann returned to the university in the middle of April, 1912. The expenses of this expedition were assumed by the Carnegie Museum of Pittsburgh, to which belongs the first series of the fishes collected; the second series remains at Indiana University.

Since his return, Mr. Manuel Gonzalez, a Colombian, who accompanied him on part of the trip, has been employed by the university to continue collecting about Bogota and to the eastward in the headwaters of the Orinoco.

Mr. Charles E. Wilson, an Indiana University student, left in December, 1912, for Tumaco, the most southerly port of Colombia on the Pacific. He spent about a month collecting in coastal streams and above Barbacoas in the Telembi, a tributary of the Patia. He then continued northward to Buenaventura, returning over the San Juan-Atrato route, collecting at various points in both of these rivers and in the Truando, one of the principal tributaries of the Atrato. He returned to the university in April, 1913. His expenses were paid by Mr. H. McK. Landon and Mr. Carl G. Fisher, both of Indianapolis.

Mr. Arthur W. Henn, another student of the university, had been with Mr. Wilson on the Telembi when both were forced to return to Tumaco with fever. When recovered Mr. Henn returned to Barbacoas by small steamer and then went by pack-train to Tuquerres, situated in the Western Cordilleras at an elevation of over 10,000 feet. From here, after some delay, he continued northward with another specially engaged pack-train to the gorge of the Patia, where this mighty stream has cloven a majestic canyon through the Western Cordilleras. The route followed here was in general that followed by the geologist A. Stübel through Ancuya, Tambo and Peñol. The gorge was reached at the mouth of the Guaitara. The expedition continued back through Pasto and Tuquerres to Barbacoas and Tumaco. Mr. Henn sailed then for Buenaventura, continued to Puerto Negria by small steamer, and returned by canoe to the lower San Juan, especially for work in the Calima, which he ascended for three days, returning overland to Buenaventura. Instructions had meanwhile been received from Dean Eigenmann directing the work to Ecuador.

Mr. Henn sailed southward to Guayaquil, where he arrived in May. A short trip was taken to Naranjito, where collecting was done in the River Chan Chan. He then went to Manabi, entering at Bahia, fishing at Chone

and Portoviejo and returning to Guayaquil by way of Manta. Several more weeks were spent in the rivers Daule and Vinces. He then ascended into the high Andean plateau over the Guayaquil and Quito Railway, collecting at various points. From Quito he descended again into the subtropical forest region at Mindo on the western slopes of Mt. Pichincha. The expedition then continued northward to El Angel, where several weeks were employed excavating old Inca tombs. Nearly 300 pieces of Inca pottery were obtained; these are now in the John Herron Art Institute of Indianapolis and the Carnegie Museum. Mr. Henn went from here down the valley of the Chota to a point below the hacienda Paramba.

Revolutionary developments and the presence of roving bands of "montoneros" made necessary a return to Quito, where the month of January was spent. Here a small collection of birds, aggregating about 65 species, was obtained, chiefly from Pichincha and the surrounding region. When quiet again prevailed, Mr. Henn returned to El Angel to secure the stored collections, continued on through Tulcan to the Colombian frontier and thence to Barbacoas, reached after twelve days of continuous travel by mule from Quito. He arrived in New York at the end of March of this year after fifteen months in the field. Aside from the collections of fishes, the collection of batrachians comprises probably 400 specimens, representing all ranges of altitude and climate. The collection of mammals is insignificant, of note is the acquisition of four skulls and one skin of the rare spectacled bear (*Tremarctos ornatus*). This expedition was made possible by the generosity of Mr. Hugh McK. Landon, of Indianapolis.

The general result of these expeditions is the definition of two geographical sub-provinces, of more or less equal value, differing somewhat in their constitution, but more so in their origin. The Pacific Province of continental South America may be divided into two sub-provinces, (1) the Colombian, extending from the Chepo basin of Panama south to the river of Esmeraldas and (2) the Ecuadorian, extending from the Guayas system south until lost, probably in the desert of Atacames. The fishes of the Pacific slope are in general widely distributed Amazonian types; none of them would cause surprise if taken at Manaos.

The Colombian sub-province is characterized by its extreme humidity. None of its rivers are large, the San Juan and Patia are the largest, but all carry a relatively immense amount of water. The few fishes which have come into them have undergone much adaptive radiation. Its fauna is much richer than that of the Ecuadorian sub-province. Its types are mostly Amazonian and among the oldest found on the continent. This fauna has certainly entered over the Atrato-San Juan route. The fishes of these two rivers are very similar and many species are common to both. The channel-fishes of the Atrato, however, have not succeeded in crossing over to the San Juan. They have spread thence to all the rivers south to Esmeraldas. Those of the Chepo and Tuyra basins of Panama have evidently also come from the Atrato. Dr. Meek says:[2]

> . . . it is quite evident that strictly South American migrants in comparatively recent times did not go far beyond the Canal Zone, and that most of these are lowland forms which came from the streams on the Atlantic side of Colombia to the Pacific side after the last gap (Atrato-Tuyra) here between the two oceans was closed. We find *Curimatus*, *Ctenolucius* and *Gasteropelecus* and other Colombian Atlantic forms in streams opposite the Rio Chagres but not in it. Some Loricariids occur in these streams and also in the Rio Chagres, but these appear to us to have probably crossed from the Pacific side streams to the Chagres and not to have migrated from the rivers of Colombia to the Chagres direct.

The Ecuadorian sub-province is characterized by its increasing aridity, which begins immediately south of the cross-ridge of Esmeraldas, is intensified below Guayaquil as shown by the Desert of Tumbez, and culminates in the desert regions of Peru. In the long dry season all of the rivers dwindle to mere puddles. Under these unfavorable conditions

[2] Publications, Field Museum of Natural History, Zoological Series, Vol. X., No. 10, 1914, p. 134.

but little evolution has taken place. The difference from the fauna to the north is the difference in species; the genera are in most cases of wide distribution.

Few species occur in both faunas, and these are such widely distributed barrier-surmounting fishes as *Rhamdia, Hoplias* and *Lebiasina.* For them the Esmeraldas ridge has not been a barrier. *Sternopygus macrurus* may have come from the north; it is the only Gymnotid found south of Esmeraldas. Sub-andine forms also occur indiscriminately in both regions. The four distinctive Pacific-slope genera are confined to this region. It is a very old fauna and an extremely meager one. *Astyanax festæ, Astyanax* or *Bryconamericus brevirostris* and *Bryconamericus peruanus,* all lowland forms, confined to this area are more intimately related among themselves than they are to the nearest geographical members of their respective genera. Either long isolation in a region offering few environmental units has caused them to converge or they have only recently arisen.

This fauna has evidently come from the east coincident with the first stages in the rise of the Andes. This possibility was suggested by Dr. Eigenmann[3] in 1909, chiefly to account for the presence of *Cetopsis occidentalis* which has near relatives in the Upper Amazon. A ridge or spur of the Andes forms the watershed between the systems of the Esmeraldas and the Guayas. On it is situated Santo Domingo de los Colorados at an elevation of 1,500 feet, but its height nearer the sea is further decreased. This seems to separate the two faunas. It is, according to Wolf,[4] of early tertiary formation and probably arose but slightly later than the beginning of the upheaval of the great western chain. The trough in which now flow the Guayas and the Daule is of subsequent alluvial formation. Deposits showing tertiary depression occur at Loja and in the headwaters of the Catamayo. Through this route possibly have entered the fishes. This point now raised more than seven thousand feet above the sea is, however, the only break in the majestic wall of the Andes.

"The distribution of the *Glandulicaudinæ* shows a strange relationship between the faunas of Transandean Colombia and southeastern Brazil. This relationship is confirmed by the distribution of *Salminus* and other fishes. The similarity is not confined to positive resemblances, but a number of types absent from northwestern Colombia are also absent from southeastern Brazil and Uruguay.

"The few genera of small fishes which succeeded in crossing or circumventing the Eastern Cordilleras of Venezuela and Colombia have undergone a remarkable radiation in Colombia. These Cordilleras very probably become a barrier before the evolution of the electric-eel, the Serrasalmoninæ and many others of the common Amazonian sub-families which are absent from Colombia. This makes very desirable a knowledge of the fauna of the region about Lake Maracaibo, where the university later plans to send an expedition."

The factors of vertical distribution are to be considered in a region so mountainous as that contiguous to the Andes. Of interest here is the *recurrence* of the same species at similar altitudes, in widely separated localities, a fact pointed out by Sir Edward Whymper among insects. The same species of *Hemibrycon* was taken at Sandoná, in the Pacific slope of the Western Cordilleras; at Ibagué in the Central Cordilleras and at Guadual, in the Atlantic slope of the Cordilleras east of Bogota, in each case at an elevation of some four thousand feet. *Bryconamericus caucanus* occurs in the Upper Cauca and at a similar altitude in the Upper Patia. *Arges cyclopium* occurs in all the high inter-andean valleys of Ecuador and is represented at Toche in the Central Cordilleras nearly four hundred miles to the north by a very similar if not identical form. This species, known as "Humboldt's fireproof fish" is the only true andean fish; in the great Andes of Ecuador it ranges as high as eleven thousand feet.

At elevations not greater than five thousand feet, a subandine fauna is encountered containing fishes such as *Pygidium, Arges, Hemibrycon, Rhoadsia* and *Piabucina.* The number

[3] Reports of the Princeton University Expeditions to Patagonia, Vol. III., 1909, p. 361.

[4] "Geografia y Geologia del Ecuador," Leipzig, 1892.

of species here is in direct proportion to the amount of rainfall. The stream gradient at this altitude is very high, but great humidity permits standing pools of water outside of the rivers themselves. Full tables of the distribution of the fishes of Colombia and Ecuador will be given in the final complete reports.

ARTHUR HENN

SPECIAL ARTICLES

POSSIBLE FACTORS IN THE VARIATIONS OF THE EARTH'S MAGNETIC FIELD

NEWALL[1] has described a very interesting experiment in which "a lamp flame held under an iron or steel wire (which is in circuit with a galvanometer), so that a short portion of the wire becomes red hot, is made to travel slowly under the wire, and it is found that a current appears in the galvanometer, the direction of the current depending on the direction in which the flame travels. Tomlinson[2] described a similar experiment at an earlier date than Newall. While this current is described as due to difference in thermoelectric quality between the iron or steel in the magnetic and non-magnetic state, yet it is suggestive of what might happen in the crust of the earth as the sun's rays fall upon its surface and warm it.

The following simple experiments were carried out with a view to getting more light on the phenomenon of earth currents and their relation to the earth's magnetic field. A board, seventy-five centimeters long and four centimeters wide, Fig. 1, had a shallow rim fastened around it so as to form a tray. At either end was fastened a zinc strip, both of which were in turn soldered to copper wires leading to a galvanometer. In this tray and covering the zinc terminals, a fairly homogeneous paste of mud was placed about one half centimeter thick. The water used in making up the mud paste was slightly acidulated with sulphuric acid to make it a better conductor. When a Bunsen flame was allowed to play on this strip of mud for some little time and then slowly moved in one or the other direction lengthwise of the tray, a current was set up in the galvanometer, depending upon the direction of the motion of the flame.

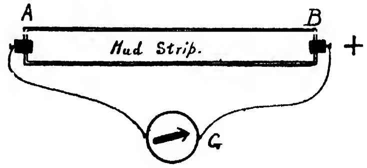

FIG. 1

If the electrode marked *B*, Fig. 1, was made positive by applying the positive pole of a dry cell to it and the negative pole to *A*, then the galvanometer gave a deflection to the left. When the flame was slowly moved from *A* toward *B*, the deflection of the galvanometer was to the right, and when the motion of the flame was reversed the current was also. This indicated that the direction of the current was opposite to that of the burner.

Suppose now this condition exists in the surface of the rotating earth as the heat rays of the sun falling upon it move from east to west. A current will be set up in the opposite direction, *i. e.*, from west to east, which will locally complete itself on the earth's surface somewhat as shown in Fig. 2.

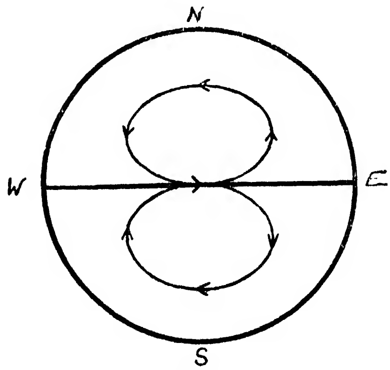

FIG. 2

It was found that the hotter the Bunsen flame for a given rate of moving, the greater

[1] Newall, *Philosophical Magazine*, June, 1888. See also Ewing's "Magnetic Induction," p. 184, 3d ed.

[2] Tomlinson, *Philosophical Magazine*, January, 1888, p. 50.

the deflection of the galvanometer. Hence we would expect that the maximum current density would be set up in the earth's crust, most directly under the sun and parallel with the equator. Consequently the resultant of all of the current filaments set up in the earth's crust would be represented by Fig. 2, in which the currents in the southern hemisphere would be opposite to that in the northern.

As this current sheet advances westward with the sun, and its magnetic field strikes the various magnetometer needles, there will be the conditions for a westward deflection in the northern hemisphere and an eastward deflection in the southern hemisphere, followed later in the day by a reversed deflection in both cases.

This experiment on the mud strip was repeated and the same results obtained with several kinds of soil to be found here locally. The relation of direction of current and direction of motion of flame was the same for the mud strip as for the iron wire investigated by Tomlinson.[2] From what we know of thermoelectric elements, it would seem possible to find conditions where the direction of the current would be the same as the flame. For instance, in large areas covered by glacial deposits if one edge of the deposit was heated more than the opposite edge we might possibly find a condition as just stated. Certain it is that oceanic areas would differ from land areas for these thermo-electric earth currents.

It was interesting to note the effect of pouring water on the strip of mud. Fairly large disturbances were produced when one or the other edge of the wet portion was heated. Local showers might thus produce local magnetic disturbances.

Blowing air either on one side or the other of a heated section of the strip also produced regular disturbances. Winds in this respect may be a possible cause of magnetic disturbances.

The cooling effect of a cloud passing over the sun or the shadow of the moon sweeping across the earth's surface in an eclipse may be made manifest by setting up these thermoelectric currents which will affect the earth's magnetic field. The temperature to which the mud was heated was bearable to the hand.

Whether these thermo-electric currents actually exist in the earth's crust as due to the heat of the sun's rays, and whether they could be picked out from other earth currents, is a matter to be investigated further, but for the present it does seem worth while to learn more about these thermo-electric currents due to a moving heat source or sink in all sorts of conductors, particularly electrolytic.

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CHANGES OF DRAINAGE IN OHIO

There is probably no state in the union in which the advance of the ice caused more decided and interesting changes in drainage than Ohio. Almost every stream of any importance in the state is now running in a new channel for at least a part of its course, and most of them for practically their entire distance.

During the progress of the reconnaissance soil survey of Ohio the writer had an opportunity to visit every section of the state and to make some study of the adjustments in drainage which resulted from the advance of the ice. Some observations and conclusions are believed to be of general interest and may be of value in interpreting changes in drainage elsewhere.

The most important relates to the probable interglacial rather than preglacial origin of many old valleys in Ohio, but the gravelly nature of all terraces along streams in or issuing from the glaciated section of the state, as contrasted with the silt and clay character of the terraces along nonglacial streams, is also worthy of mention, as this fact often helps to determine the age as well as the direction of flow of some old streams.

The course of the old Kanawha River was definitely traced many years ago through the hills east of the Scioto in southern Ohio as far north as Waverly, but as to its further course there has been some doubt. The occurrence of deposits, similar to those in its old

channel, upon the west side of the Scioto northeastward from Waverly and the presence of an old valley extending on for several miles beyond Richmondale, carrying like material, and finally turning westward to the Scioto again below Chillicothe (see Waverly and Chillicothe topographic sheets) proves conclusively that the old Kanawha flowed northward as far as Chillicothe. It seems very probable that it also extended northward through the present Scioto Valley to the vicinity of Marion and then possibly on northward into Lake Erie.

It will be recalled by those familiar with the topography of Ohio that the highest point in the state is near Bellefontaine in Logan County. Although the rocks in this section dip to the southeast the hills east of Bellefontaine are capped with the same formations that are found around Delaware, although the latter is approximately 40 miles east and 600 feet lower in elevation. The large amount of erosion which has been necessary to the formation of the Scioto Valley would seem to indicate very strongly the continuance of the old Kanawha northward.

It has been shown by Tight[1] that an old valley leaves the Scioto about halfway between Columbus and Circleville and extends northeastward by Buckeye Lake and Newark to the Muskingum at Dresden. From this point the valley extends on northeastward up the Muskingum and Tuscarawas to Canal Dover and thence on northward by Beach City and Justus to Massillon. Beyond this point its course is rather difficult to determine because of the deep drift and possibly for other reasons which will be evident later.

This valley has been considered as a possible channel of the old Kanawha River although Leverett[2] states that he has "found decisive evidence against the suggested northeastward line, in the presence of an old divide now crossed by the Tuscarawas between Zoar and Canal Dover." He apparently rejects the northward extension of the old valley suggested above because of a restriction in width near Strasburg. However, the narrowest place is almost one half mile in width (about 2,300 feet), or wider than many places along the Ohio River to-day, and the restriction is believed to be due to the character of the rock. Almost as narrow a restriction occurs just north of Conesville (see Navarre, Canal Dover and Conesville topographic sheets). A rather careful study during last summer convinced the writer that the Tuscarawas from Navarre to Canal Dover was deflected by the Wisconsin glaciation and that the present course by Zoar and across the divide to Canal Dover was opened up during this time.

While the writer does not believe that this old valley was ever occupied by the Kanawha, this opinion is based upon other evidence than the presence of the divide near Canal Dover. It is believed that this old valley, as well as many others in Ohio, is of *interglacial* origin while the Kanawha is *preglacial*. Some of the reasons for this conclusion will be briefly presented.

From Chillicothe southward the Scioto River has a very much wider valley than the Hocking, Muskingum, or even the Ohio in much of its course. In fact these streams have practically no bottom lands. The Scioto Valley was evidently formed after the change in the Kanawha drainage because it is 100 feet or more lower than the old Kanawha Valley and therefore could not have been carved out by a northward flowing stream. It, therefore, becomes necessary to explain the greater width of this valley as compared with the valleys of the other streams. The most satisfactory explanation seems to be that during interglacial time this valley formed the line of discharge for all of the drainage northeastward, at least as far as the Tuscarawas drainage now extends, and it may be possible that the first change in the Ohio drainage was also across the divide between Canton and Alliance and down this valley. The elevation here, with the drift added, is hardly equal to that of the hills near New Martinsville and, if the advance of the ice, which first obstructed the northward Ohio drainage, did not come as

[1] *Bull. Dennison University*, Vol. VIII., Pt. II., 1894, pp. 35–61.

[2] Mon. 41, U. S. Geol. Survey, p. 103.

far south as Alliance, which seems very probable, the Ohio might easily have first broken over here and have flowed westward.[3] The deep drift in this section makes it difficult to determine this point but the width of the Tuscarawas Valley, the narrowness of the present Ohio Valley and the occurrence of lacustrine deposits north of Alliance and mixed more or less with the drift in many parts of the Grand River Valley seem to strongly favor such an hypothesis.

It is generally believed by geologists that the preglacial divide of the Ohio drainage was near New Martinsville, West Virginia. A study of the direction of the streams along the Tuscarawas would seem to indicate that the preglacial divide along this stream was near Port Washington and that Big Stillwater, Conotton and Big Sandy Creeks flowed northwest, the former by Canal Dover along the present course of Sugar Creek reversed at least beyond Beach City. Whether this stream joined the other two near Justus or Navarre or flowed on northwest separately can not be stated definitely because of the drift and the changes brought about by the advance of the ice. Below Port Washington the drainage was probably westward into the Scioto Valley and old Kanawha system.

Upon the first advance of the ice southward of Lake Erie the drainage of all northward flowing streams was obstructed and it became necessary for their waters to seek other outlets. As the country to the west was in general lower the streams were dammed up until they finally ran over the lowest divide on the west. There was a tendency for them to follow in a general way the ice border, just as the Ohio and Missouri Rivers to-day follow rather closely around the southern extension of the ice.

In view of the above considerations it is believed that the Tuscarawas-Scioto Valley had its origin in an early advance of the ice and represents the principal drainage line during interglacial time, and that the advance of the ice farther southward during the later glaciations forced the Hocking, Muskingum and possibly the Upper Ohio to change to their present channels. Such a hypothesis makes it possible to explain many very peculiar connections between old valleys, which are very difficult to understand otherwise. If the time which elapsed between the different advances of the ice, had been estimated with any degree of approximation it can be easily understood how much larger valleys may have been formed during interglacial periods than since. The matter appears to deserve more consideration in the interpretation of changes of drainage than it has been given heretofore.

George N. Coffey

[3] Since this article was written the writer has had an opportunity to make further observations in the country north of Alliance and has found further evidence, particularly an old valley near Ravenna, to substantiate the hypothesis that the Ohio River first broke over in this section and formed the Tuscarawas-Scioto Valley.

THE POISONOUS NATURE OF THE STINGING HAIRS OF JATROPHA URENS

Jatropha urens is one of the most abundant Euphorbiaceous plants growing in or around the savannas of the Pacific coast of Central America. Its spread is favored by the fact that the cattle avoid it, and because it is not kept down by the too indolent owners of the pastures. Everywhere it has the reputation of being extremely dangerous, on account of its poisonous effects.

The plant is easily recognized: It is herbaceous, 0.5 to 1.5 meter high, regularly ramified, with large palmatilobate leaves, white flowers and small, 3-celled capsules. All parts, trunk, leaves, flowers and fruits are covered with long, hard and glossy, stinging hairs, which protect the plant as barbed wire protects the fortifications of to-day. It would seem as if the remarkable glossiness of the stinging hairs might warn the curious against approaching or touching. As a mater of fact, the animals either by instinct, or on account of the wisdom acquired through some previous experience, avoid contact with it.

The vernacular name of *Jatropha urens* is "ortiga" or "ortiga brava" (nettle) in Panama, and other parts of Central America, in-

dicating somewhat its noxious effects. Sometimes it is also called "chichicaste."

The stinging hairs of *Jatropha urens* show the same structure as those of the common nettle (Urticaceæ), though the two plants belong to different families. The poison is produced by a cell of the epidermis which, during the growth, swells up, forming a goblet-shaped bulb, set into the surrounding tissue. The hair then represents a long tube, the walls of which have incrustations of silicic acid in the upper part and are calcified in the lower parts, so that they are very brittle and break at the lightest touch. Near the top this cell expands a little, in the form of a miniature hat with very thin walls, so that when touched, it breaks in an oblique direction, forming the point of a cannula, which enters the skin of animal or man. At the same time the poisonous liquid of the cell is discharged into the wound, and produces instantly a local inflammation. The mechanism is, in fact, the same as that of the poison fang of the snakes, and it is also similar to the cannula of the surgeon.

To estimate the formidable effects of the hair and the intensity of its poisonous liquids, it has been calculated that about 10,000 hairs of the common nettle may produce one drop of poison (0.05 c.cm.). As in the case I am going to mention, about 10 hairs of the *Jatropha* were broken. It may be calculated on the same basis that about 0.00005 c.cm. of poison entered the wound. This is, however, a low estimate, because the hairs of our plant and their inner cavity are larger than those of the common nettle and the amount of poison introduced into the system in the following occurrence was probably much larger than it would have been in the case of an equal contact with *Urtica urens.*

On an excursion along the San Felix River, in eastern Chiriqui, with Dr. MacDonald, geologist of the Canal Commission, the writer became acquainted with *Jatropha urens* by unavoidable contact with a single specimen of the plant. All at once he felt an intense burning on the left hand, where about 10 of the stinging hairs had entered pretty deep into the skin. The inflammation produced by this touch was very similar to that produced by nettles, but the pain soon increased, the whole hand began to swell and inside of half an hour had assumed a monstrous shape. Then the arm commenced to swell also, the right hand and arm, without having been innoculated, yet showed the same abnormal symptoms, and a very strong itching sensation was felt all over the upper part of the body. At about the same time parts of the face, around the eyes and nose, swelled considerably. The itching sensation rapidly spread over the abdomen and the lower extremities and red pimples appeared everywhere. In less than an hour the poison had extended over the whole surface of the body, and its entrance into the blood current was indicated by the corresponding physiological reaction of the interior organs. The palpitation of the heart became extremely accelerated and the mind was soon overcome by an agonizing depression. The respiration seemed to be delayed as if under a great pressure, cold sweat broke out, and the patient gave way altogether, remaining unconscious for more than an hour, except for feverish dreams. After coming back to his senses, he had several fits of copious vomiting, from which it may be surmised that the poison was slowly eliminated from the organism. The weakness, however, remained for several days.

A case of such extreme effects, which might have killed a man of less strength than the writer, has never been recorded, as far as the literature on the subject shows. Undoubtedly the intensity of the intoxication was due to the rather strong contact with the plant, which caused a considerable amount of poison to be introduced into the blood circulation.

Many other tropical plants, among them some *Urticaceæ* and *Loasaceæ,* have such deadly stinging hairs, the poison of which is active enough to kill a man, even in a relatively small dose. The only way of allaying its effects would be to neutralize or precipitate it by means of a prompt application of chloride of lime, ammonia or sodium permanganate.

OTTO LUTZ

INSTITUTO NACIONAL DE PANAMA,
PANAMA, R. DE P.

SCIENCE

FRIDAY, OCTOBER 30, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

MULTIPLICITY OF CROPS AS A MEANS OF INCREASING THE FUTURE FOOD SUPPLY[1]

ECONOMISTS prophesy a deficiency in the world's food supply. The cost of living everywhere portends accuracy in their divination. The fast and furious struggle between nations and individuals for land upon which to grow food augurs lean years to come. Census enumerations of population presage sooner or later a dearth of ammunition among the multiplying peoples of the earth to carry on the battle of life. Of all this you need to be reminded rather than informed.

So many men have stated and attempted to solve the problem of the future food supply that it would seem that the subject has been wholly talked out from the facts at hand. Indeed, there has been so much said and written about hard times at hand and famine ahead that I doubt if you are pleased to have your premonitions reawakened by further forebodings and to be forced, through the prestige of the president's chair, to give attention to a subject which has been so much discussed. Thrashing over old straw in the presidential chair is, I quite agree with you, a most abominable practise and I have done my best to bring a few sheaves of grain to the thrashing I am now beginning.

Agricultural economists discuss three rather general means of securing a food supply for those who live later when the earth teems with human beings. These are: conservation of resources; greater acreages under cultivation; and increased

[1] Presidential address, Society for Horticultural Science, Washington, D. C., 1913.

yields from improved plants and through better tillage. It is difficult to anticipate the problems that will confront us when people swarm on the land, as now in India or China, but I venture the prediction that if in that day "the evil arrows of famine" are sent upon us, a fourth means of supplying food will be found quite as important as the three named.

We shall find, long before famine overtakes us, that the natural capacity of soils and climates to produce a diversity of crops is one of the greatest resources for an increased food supply. As yet, multiplicity of crops as a means of augmenting the supply of food has received little attention and I want to bring you to a better realization of its possibilities in the half hour at my disposal, attempting to show, in particular, how greatly the necessities and luxuries of life can be increased by the domestication of wild esculents; by better distribution of little-known food plants; and by the amelioration of crops we now grow through breeding them with wild or little-known relatives.

Few, even among those who have given special attention to agricultural crops, have a proper conception of the number that might be grown. De Candolle, one of the few men of science who have made a systematic study of domesticated plants, and whose "Origin of Cultivated Plants" has long been sanctioned by science as authoritative, is much to blame for the current misconception as to the number of plants under cultivation. By conveying the idea that his book covers the whole field, De Candolle prepared the ground for a fine crop of misunderstandings.

Humboldt had stated in 1807 that

> The origin, the first home of the plants most useful to man, and which have accompanied him from the remotest epochs, is a secret as impenetrable as the dwelling of all our domesticated animals.

De Candolle set out to disprove Humboldt. He assorted cultivated plants in 247 species and ascertained very accurately the histories of 244 out of the total number. De Candolle's thoroughness, patience, judgment, affluence of knowledge, clear logic and felicity of expression, make his book so trustworthy and valuable in most particulars, that we have accepted it as the final word in all particulars, overlooking his faulty enumeration and forgetting that most of his material was gathered more than a half century ago.

My first task is to establish the fact that the number of plants now cultivated for food the world over is not appreciated in either science or practise. Neither are botanists nor agriculturists seemingly well aware of the number of edible plants not domesticated which are in times of stress used in various parts of the world for food, many of which can well be grown for food. Your attention must be called to the number of these.

Inspiration for this discussion of the undeveloped food resources of the plant-kingdom came to the speaker from the use of notes left at the New York Agricultural Experiment Station by the first director of the station, the late Dr. E. Lewis Sturtevant, who gave most of his life to the study of economic botany. His pen contributions on cultivated plants in agricultural and botanical magazines cover thirty years and number many titles. In addition, the unpublished material just mentioned, under the heading "Edible Plants of the World" takes up over 1,600 typewritten pages. During his life, Dr. Sturtevant was in the full tide of American science, but I am sure could he have lived to publish the great treatise which he had planned on edible plants, and upon which he worked for twenty years, we should give him much higher rank with giants of science,

and that his book would now be the *magnum opus* of economic botany.

De Candolle, as we have seen, includes but 247 cultivated species in his work. This is approximately the number generally thought to minister to the alimentary wants of man. Sturtevant, in his notes on edible plants, enumerates 1,113 domesticated species now cultivated, and a total of 4,447 species, some part or parts of which are edible. Following De Candolle, Sturtevant made use of botany, archeology, paleontology, history and philology in obtaining his data. He searched the literature of the world from the earliest records in Egyptian, Chinese and Phœnician until the time of his death to make a complete record of the edible plants of the world. Sturtevant's were the species, too, of a generation ago, many of which have since been divided twice, thrice or oftener by later botanists. It is said that no food plant of established field culture has ever gone out of cultivation, an approximate truth, at least, from which we may presume that the number of cultivated plants is not smaller than the numbers given from our author's notes.

In leaving this phase of my subject, I can not but say that, despite the fulness of Sturtevant's notes, the feeling comes in reading them, as it does in reading De Candolle, Darwin or whoever has written on the domestication of plants, that what has so far been found out is so little in comparison to what we ought to know regarding the modification of cultivated plants by man, that our present knowledge but makes more apparent the dire poverty of our information.

Passing now to a more direct discussion of the subject in hand, I have to say that I have chosen to discuss three general means of developing the latent possibilities in the plant-kingdom for agriculture. It may help to hold your attention if I discuss these in order of their importance—the most important last. They are: First, the domestication of the native plants of any region. Second, better distribution of plants now cultivated. Third, the utilization of hybridization to bring into being new types of plants better suited to cultivation and to the uses of man.

In the matter of domesticating plants let us glance hastily at what has and what can be done in our own country. In De Candolle's treatise we make but a poor showing, indeed. Out of his 247 cultivated species but 45 are accredited to the New World and but three of these—the pumpkin, Jerusalem artichoke and persimmon—come from North America. To these three Sturtevant adds about thirty. The poor showing made by our continent in furnishing food plants, it must be made plain, is not due to original inferiority. The number would be vastly greater, as Asa Gray long ago pointed out, had civilization begun in this rather than in the Old World. It is probable, indeed, that the numbers would be approximately equal if civilization had begun as early in the Western as in the Eastern Hemisphere.

What are some of these plants that Gray and other botanists have so often told us might have been and may yet profitably be domesticated? The list is far too long to catalogue, but you will permit me time for a few examples, choosing those that are still worth domesticating for some special purpose or environment. Fruits give us most examples.

Wild fruits abound in North America. The continent is a natural orchard. More than 200 species of tree, bush, vine and small fruits were commonly used by the aborigines for food, not counting nuts, those occasionally used, and numerous rarities. In its plums, grapes, raspberries,

blackberries, dewberries, cranberries and gooseberries North America has already given the world a great variety of new fruits. There are now under cultivation 11 American species of plums, of which there are 433 pure-bred and 155 hybrid varieties; 15 species of American grapes with 404 pure and 790 hybrid varieties; 4 species of raspberries with 280 varieties; 6 species of blackberries with 86 varieties; 5 species of dewberries with 23 varieties; 2 species of cranberries with 60 varieties and 2 gooseberries with 35 varieties. Here are 45 species of American fruits with 2,226 varieties, domesticated within approximately a half century. De Candolle named none of them. The final note of exultation at this really magnificent achievement of American horticulture would typically be uttered in a boast as to the number of millions of dollars these fruits bring fruit-growers each year, but science is not sordid and the calculation, I am sure, would not interest you.

What more can be done? The possibilities of the fruits named have by no means been exhausted. The fruit of the wild plum, *Prunus maritima,* an inhabitant of sea-beaches and dunes from New Brunswick to the Carolinas, is a common article of trade in the region in which it grows, but notwithstanding the fact that it readily breaks into innumerable forms and is a most promising subject under hybridization, practically nothing has yet been done toward domesticating it. Few plants grow under such varied conditions as our wild grapes. Not all have been brought under subjugation, though nearly all have horticultural possibilities. It is certain that some grape can be grown in every agricultural region of the United States. The blueberry and huckleberry, finest of fruits, and now the most valuable American wild fruits, the crops bringing several millions of dollars annually, are not yet domesticated. Coville has demonstrated that the blueberry can be cultivated. Some time we should have numerous varieties of the several blueberries and huckleberries to enrich pine plains, mountain tracts, swamps and waste lands that otherwise are all but worthless. A score or more native species of gooseberries and currants can be domesticated and should some time extend the culture of these fruits from the Gulf of Mexico to the Arctic Circle. There are many forms of juneberries widely distributed in the United States and Canada, from which several varieties are now cultivated. The elderberry is represented by a dozen or more cultivated varieties, one of which, brought to my attention the past season, produced a half hundred enormous clusters, a single cluster being made up of 2,208 berries, each a third of an inch in diameter.

These are but a few of the fruits—others which can only be named are: the anonas and their kin from Florida; the native crab-apples and thorn-apples; the wineberry, the buffalo-berry and several wild cherries; the cloud-berry prized in Labrador; the crow-berry of cold and Arctic America; the high-bush cranberry; native mulberries; opuntias and other cacti for the deserts; the paw-paw, the persimmon, and the well-known and much-used salal and salmon berries of the west and north.

The pecan, the chestnut and the hickory-nut are the only native nuts domesticated, but some time forest and waste places can be planted not only to the nuts named, but to improved varieties of acorns, beechnuts, butternuts, filberts, hazels, chinquapins and nut-pines, to utilize waste lands, to diversify diet and to furnish articles of food that can be shipped long distances and be kept from year to year. The fad of to-day which substitutes nuts for meat may become a necessity to-morrow. Meanwhile

it is interesting to note that the pecan has become within a few decades so important a crop that optimistic growers predict in another half century that pecan groves will be second only to the cotton fields in the south. A recent bulletin from the United States Department of Agriculture describes 67 varieties, of which more than a million and a half trees have been planted.

It is doubtful whether we are to change general agriculture much by the domestication at this late date of new native grains, though many may well be introduced from other regions and wonderful improvement through plant-breeding is, as all know, now taking place. Raw material exists in America for domestication, but it is not probable that we shall ever use it extensively.

There are, however, a number of native vegetables worth cultivating. The native beans and teparies in the semi-arid and sub-tropical southwest to which Freeman, of the Arizona station, has called attention, grown perhaps for thousands of years by the aborigines, seem likely to prove timely crops for the dry-farmers of the southwest. Professor Freeman has isolated 70 distinct types of these beans and teparies, suggesting that many horticultural sorts may be developed from his foundation stock. The ground-nut, *Apios tuberosa,* furnished food for the French at Port Royal in 1613 and the Pilgrims at Plymouth in 1620, and as a crop for forests might again be used. There are a score or more species of *Physalis,* or ground cherries, native to North America, several of which are promising vegetables and have been more or less used by pioneers. *Solanum nigrum,* the nightshade, a cosmopolite of America and Europe, recently much advertised under several misleading names, and its congener, *Solanum triflorum,* both really wild tomatoes, are worthy of cultivation and in fact are readily yielding to improvement. *Amaranthus retroflexus,* one of the common pigweeds of gardens, according to Watson, is cultivated for its seeds by the Arizona Indians. In China and Japan the corms or tubers of a species of *Sagittaria* are commonly sold for food. There are several American species, one of which at least was used wherever found by the Indians, and under the name arrowhead, swan potato and swamp potato has given welcome sustenance to pioneers. Our native lotus, a species of *Nelumbo,* was much prized by the aborigines, seeds, roots and stalks being eaten. *Sagittaria* and *Nelumbo* furnish starting points for valuable food plants for countless numbers of acres of water-covered marshes when the need to utilize these now waste places becomes pressing.

The temptation is strong to continue this discussion of the domestication of native plants, but time demands that I pass to a consideration of the second potential of an increased diet, that of better distribution of the world's food-producing plants.

Beginning with the discovery of the New World, botanical and agricultural explorations have been carried on with zeal, and food plants have been interchanged freely between newly discovered lands and older civilizations. Yet in these centuries the food-plant floras of races have been changed but little. Quite too often a crop is found to be the monopoly of a race or nation irrespective of soil and climate, factors which ought to impose a cultivated flora. It would seem that agriculturists would quickly adopt food plants grown elsewhere of which the advantage is evident, and be thereby diverted from the cultivation of poorer crops in their own country. Yet the introduction of foreign plants is usually arrested, if not actually opposed, by the timidity of agriculture, and it has been most difficult to introduce new crops into

old regions. This conservation on the part of those who grow the food plants of the country is due to a universal dislike in the animal kingdom, most strongly developed in the human family, to eating unfamiliar foods. But travel is making all people less and less fastidious as to foods, as the numerous new foreign dishes in daily use in our own homes give evidence. Only savages and those who must struggle for sufficient food to sustain life live on one or a few foods.

Let us hastily run over a few foreign plants that may well receive more attention in America, naming fruits first as of most interest to this audience. Japanese plums and persimmons came to America in the medieval days of horticultural progress, and interest in them seems to have ceased. We need new importations of the many types not yet in the country. The fig is an ancient immigrant, but I am told that many desirable relatives were left behind. Date culture is now a most promising infant industry in the southwest. The Chinese jujube promises to be one of the most valuable of the many plants recently introduced into this country. The jujube is a hardy tree which has been cultivated in China for more than 4,000 years, being one of the five principal fruits of the new republic. There are hundreds of varieties differing in flavor and sizes, some growing less than an inch in length and others equaling the size of a hen's egg. One variety is seedless. Some kinds are eaten fresh, some are stewed.

Among the newest of the new on probation, but all clamoring for recognition, are the avocada from tropical America; the feijoa from Brazil; a dozen or more annonaceous fruits from the tropics, of which the cherimoya seems now to be most prominent; an edible Osage orange from Central China; the roselle, an annual from the Old World tropics, valuable for its fruit, stalks and seed. Several species of *Berberis* supply a refreshing fruit in northern Asia and might add variety to the rather spare fruit diet of the colder parts of this continent. Beside these are innumerable new citrus fruits, the number of species and varieties of which seem to be legion—the speaker is neither able to enumerate them nor to tell where they begin or where they leave off. Swingle's splendid work with this genus is one of the most notable contributions to horticulture in recent years.

The mango has long been grown in Florida, but interest in mangos has recently been renewed through the introduction of choice Indian varieties. Poponoe describes 312 varieties of mangos grown in various parts of the world, of which as yet I judge there are but few in America, though they are not difficult to grow in Florida, California or in our insular possessions. A quotation from Fairchild suggests the possible future of the mango in America. He says:

> The mango is one of the really great fruits of the world. . . . There are probably more varieties of mangos than there are of peaches. I have heard of one collection of five hundred different sorts in India. There are exquisitely flavored varieties no larger than a plum, and there are delicious sorts, the fruits of which are six pounds in weight. . . . These fine varieties, practically as free from fiber as a freestone peach, can be eaten with a spoon as easily as a canteloupe. Trainloads of these are shipped from the mango-growing centers of India and distributed in the densely peopled cities of that great semitropical empire.

No one can read Bayard Taylor's fervent praise of the durian and the mangosteen and not desire to grow these fruits in America. This is his panegyric on the durian.

> Of all fruits, at first the most intolerable; but said, by those who have smothered their preju-

dices, to be of all fruits, at last, the most indispensable. When it is brought to you at first, you clamor till it is removed; if there are durians in the next room to you, you can not sleep. Chloride of lime and disinfectants seem to be its necessary remedy. To eat it seems to be a sacrifice of self-respect; but, endure it for a while, with closed nostrils, taste it once or twice, and you will cry for durians thenceforth, even—I blush to write it—even before the glorious mangosteen.

Listen to his laudation of the "glorious mangosteen."

Beautiful to sight, smell and taste, it hangs among its glossy leaves the prince of fruits. Cut through the shaded green and purple of the rind, and lift the upper half as if it were the cover of a dish, and the pulp of half-transparent, creamy whiteness stands in segments like an orange, but rimmed with darkest crimson where the rind was cut. It looks too beautiful to eat; but how the rarest, sweetest essence of the tropics seems to dwell in it as it melts to your delightful taste.

One need not titillate the palate to enjoy such fruit. Can they be so delectable? Surely we can find a place for them somewhere in America.

Let us turn to a few examples of promising vegetable and farm crops of foreign countries not yet cultivated in the United States. Only those which give most emphasis to the present paper can be mentioned.

All know that rice furnishes the chief food of China, but few are aware that sorghum is as important a crop in Asia as rice and that it is the chief food of a large part of Africa. In China not only are the stalks of sorghum used, but bread is made from the seeds. In parts of India, sorghum is the staff of life. The Zulu Kaffirs live on the stalks, which are chewed and sucked, and Livingstone says "the people grow fat thereon." The several species of yams constitute one of the cheapest and most widely distributed food plants in the world, yet the yam is little grown in America. Several genera of Aroideæ, as *Caladium, Alocasia, Colocasia* and *Arum*, each with innumerable varieties, furnish taro, arrowroot, ape and other more or less familiar food to the South Sea islanders. In a bulletin from the United States Department of Agriculture, under the title, "Promising Root Crops for the South," these Aroids, called under their native names of yautias, taros and dasheens, are recommended as most valuable wet-land root crops for the South Atlantic and Gulf States. Of the place of the cocoanut in the world's economy I need not speak. Varieties of *Maranta* were grown in Mississippi and Georgia in 1849, but disappeared. From one of the several species of this genus comes the arrowroot of commerce. Arrowroot is a favorite food of the Feejees and their neighbors, as well as of the inhabitants of Cape Colony, Natal and Queensland. May not arrowroot some time be produced profitably in America? The banana has been on our tables less than a generation, yet it is now one of the commonest foods. There are several species and many varieties yet to be introduced into the tropics of America. The leaves and buds of several agaves furnish an abundant and a very palatable food to our southern neighbors. From plants of the large genus *Manihot* of equatorial regions, tapioca is made under conditions which could be greatly improved. As cassava, one of these manihots is already important in the United States and may some time compete with corn and wheat in the food supply of the country.

To quench the thirst of the teeming millions in time to come there may be a multiplicity of beverages as well as of foods to mitigate hunger. In Arabia several millions of people drink khat, while in southern South America as many more millions allay their thirst with maté. Maté, according to Fairchild, can be produced

at but a fraction of the cost of tea and supplies the same alkaloid in a more easily soluble form. Both contain thein, the active principle in "the cups that cheer but not inebriate." Sturtevant names twelve plants the leaves of which are used in different parts of the world to adulterate or in place of tea. We have but just acquired the use of cocoa and chocolate from the natives of our American tropics and of cocacola from the negroes of Africa, and it is not unlikely that we shall find other similar stimulants. For drinkers of more ardent beverages, if King Alcohol continues to reign, there is an abundance, the diversity and cheapness of which probably will ever as now be regulated by taste and taxes.

Time prevents my naming other valuable foreign plants that deserve to be tried in our agriculture. It is fortunate for American farming that men from the United States Department of Agriculture are now searching everywhere for new material. Saul went in search of asses and came back with a crown. So these men sent to foreign countries for material, possibly commonplace enough, are bringing back treasures the value of which in many cases will be incalculable. Introduction of seeds and plants for the nation is work to which the institutions represented here should lend aid in every way possible.

The last of the three means of developing plants for food, and as I believe the most important, is by using either foreign species or wild native species to hybridize with established crop-plants. It needs but a brief statement of what has been accomplished in increasing hardiness, productiveness, disease resistance, adaptability to soil and other essentials of standard crop-plants, to show that through hybridization of related species we have probably the best means of augmenting our diet. Let us glance at a few recent accomplishments of hybridization, noting chiefly results with horticultural plants.

Downing in 1872 described 286 varieties of 4 species of plums. In the 40 years that have elapsed the number has increased to 1,937 varieties representing 16 species. Now the significant thing is that whereas Downing's plums were pure-bred species, 155 of the present cultivated plum flora are hybrids between species. Downing could recommend plums for only a few favored regions. Some kind of plum can be grown now in every agricultural region in North America. Even more remarkable is the part hybrids have played in the evolution of American grapes. At the beginning of the nineteenth century, the grape could not be called a cultivated crop on this continent. Now there are 16 species and 1,194 varieties, the most significant fact being that 790 or three fourths of the total number are hybrids. The grape through hybridization has become one of the commonest cultivated plants. The genus *Rubus* promises to attract and distract horticulturists next. As nearly as I can make out there are about 60 species of *Rubus* in North America. In the two completed parts of Focke's "Species Ruborum," 273 species are described. Raspberries, blackberries, dewberries and their like hybridize freely and we already have in the loganberry, the purple-cane raspberry, the wineberry and in the blackberry-dewberry crosses valuable fruits. If any considerable number of Focke's several hundred species can be similarly mixed and amalgamated, the genus *Rubus* will be one of the most valuable groups of fruits.

The speaker is studying cultivated cherries. When the work began a few years ago about a score of species were in sight. Koehne, a recent botanical monographer of the sub-genus *Cerasus*, to which

our edible cherries belong, describes 119 species, many of them but recently collected by Wilson in Asia. There are enough hybrids between species to indicate that cultivated cherries will some time be as diversified as plums and with quite as much advantage to the fruit.

Webber's and Swingle's work in breeding hardy citrus fruits; blight-resisting pears as a result of crossing *Pyrus communis* and *Pyrus sinensis;* Burbank's spectacular hybrid creations; the diversity of types of tomatoes, potatoes, egg-plant, peppers, beans, cucurbits and other vegetables, not to mention roses, chrysanthemums, orchids and innumerable flowers, suggest the possibilities of hybridization. We have not done what lies within our reach in crossing cereals—corn, wheat, oats, rye, buckwheat, the last especially, remain yet to be touched by the magic wand of hybridization. Hybrid walnuts, chestnuts, hickories and oaks, promise a wonderful improvement in nuts.

Truth is we do not know how much nor what material we have to work with in many of the group of plants I have named, lending color to the saying that the plants with which man has most to do and which render him greatest service are those which the botanists know least. This brings me to the last division of my subject.

Nothing is more certain than that we are at the beginning of a most fertile period in the introduction of new and the improvement of old food-plants. Yet agricultural institutions are most illy prepared to take part in the movement. "Art is long and time is fleeting," can be said of no human effort more truly than of the improvement of plants, and haste should be made for better preparation. Looking over the material that is usable in agricultural institutions, it seems that we are sadly lacking in the wherewithal upon which to begin. It is indispensable for effective work that we have an abundance of material and that we know well the plants with which we are to work.

How may the material be had? We are fortunate in the United States in having the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture for the importation of foreign plants. This office has effective machinery for the work. It maintains agricultural explorers in foreign countries. It is in direct contact with the agricultural institutions of other countries as well as with plant-collectors, explorers, consuls, officers of other countries and missionaries. Through these agents it can reach the uttermost parts of the world. Moreover, it has trained men to identify, to inventory, to propagate and to distribute foreign plants. This office can better meet quarantine regulations than can private experimenters or state institutions. All interested in foreign plants ought to work in cooperation with the Office of Foreign Seed and Plant Introduction of the Department of Agriculture.

To be used advantageously material must be near at hand. This means that there must be botanic gardens. There should be in every distinct agricultural region of the country a garden where may be found the food plants of the world suitable for the region. It is strange that in the lavish expenditure of state and federal money in the agricultural institutions of the land, that so little has been done to establish and maintain comprehensive plantations of economic plants. Now that the amelioration of plants is a part of the work of agricultural colleges and stations it would seem that the establishment of such gardens is imperative. True, there are botanic gardens, but the museum idea is dominant in most of them—they contain the curiosities of the vegetable kingdom, or they show the

ornamental and beautiful, or they are used for purposes of instruction. We need agricultural gardens in which agricultural plants are dominant rather than recessive.

There is another difficulty quite as detrimental to progress as inability to obtain material. It is the lack of trustworthy information in regard to economic plants. Quite as necessary as agricultural gardens is an agricultural botany. In this botany must be set forth, besides descriptions of species, the habitat, the migrations, the geographical relations to other plants, the changes that have occurred, how the plant is affected by man-given environment, and all similar data. Physiological facts regarding germination, leafing, flowering and fruiting must be given. The production of such a book is a consummation devoutly to be wished. At present the information needed is best supplied by Bailey's splendid cyclopedias, but there is need of more historical and biological knowledge in agricultural botany.

I had thought to say a few words about the men who are to do this work. Material and books do not create. The man has not been lost sight of, but I should have to set forth his temper and training too hurriedly even if I could properly conceive them. But from the beginning to the end of this new shaping of food crops, the individual man trained for the work will be dominant. The work to be done, however, is so vast that we can not make an appreciable showing unless the task be divided among a great number of workers. Those who will do most are such as can concentrate on particular problems the sifted experience and knowledge of the world. Many may sow, but only the strong can garner.

There should be unity of action to avoid waste. What more pathetic spectacle than that of isolated men in our agricultural institutions attacking one and the same problem in which they duplicate errors and waste their efforts in what too often proves with all to be petty circle-squaring. Much of this appalling waste can be avoided by a proper spirit of cooperation. By all means let us cooperate in the amelioration of plants.

In conclusion, I must end as I began by calling attention to the great probability of a near-at-hand deficiency of food. I must again urge the importance of making use of every means of increasing the supply. I have tried to call attention to the desirability of growing a greater number of food-plants as one of the means. Not to attempt to develop and utilize to its highest efficiency the vast wealth of material in the plant-kingdom for the world's food is improvidence and is a reckless ignoring on your part and mine of splendid opportunities to serve our fellow men. It is my hope that the horticultural departments of the agricultural colleges and experiment stations of North America, represented by members of this society, may become active agents in increasing the number of food crops and thereby the world's food supply.

U. P. Hedrick

HEADSHIP AND ORGANIZATION OF CLINICAL DEPARTMENTS OF FIRST-CLASS MEDICAL SCHOOLS[1]

Two recent official manifestations with reference to the problem of full-time clinical positions deserve to be put at the head of our

[1] This manuscript has been prepared for the president and trustees of a university in answer to the following questions:

"First: What should be the relation of the hospital to a first-class medical school? The question is asked . . . to bring out the ideal relationship. For instance, to what extent should the school own, control, or manage its teaching hospital in its medical and in its administrative functions.

discussion, because they come from the most important educational bodies in medical matters in this country and because they throw light upon the acuteness and the present status of our problem. (1) The Johns Hopkins University has recently appointed full-time professors of medicine, surgery and pediatrics. There under the term "full-time professorship" two obligations are included. In the first place the head of a clinical department must give as much of his time to his department as other full-time university professors give of their time, for instance, as the professors of physiology and pathology give to their departments. In the second place, the head of a clinical department can not give any of his spare time to any clinical venture which may bring him material gain. It is interesting and instructive to find that this plan was advocated twelve years ago by Dr. L. F. Barker, while he was professor of anatomy at the University of Chicago. Here is what he said then:[2]

They (the full-time professors of clinical subjects) should be well paid by the universities. They should not engage in private practise even if the university has to pay them double the ordinary salary now paid a university professor to retain them wholly in university work. If any patients at all outside the hospital were seen in consultation, and there is some force in the argument that the well-to-do public should, at least in some rare and difficult cases, be permitted to profit by the opinion and advice of the university professor, the fees received from them may be contributed to the budgets of the hospital themselves, in order to remove all temptation from the staff.

2. The second manifestation is contained in the official Report of the Council of Medical Education made at the last meeting of the American Medical Association.[3] This report speaks of the Johns Hopkins plan, according to which the full-time professors "may do private practise, but that fees from that practise are to be turned into the university treasury and not into their own pockets," as *grotesque*. The report lays stress upon the fact that this plan was proposed by non-medical men (that is, the General Education Board) who "do not have the medical point of view and do not understand the complex functions demanded of the clinical teacher." It may be said here in parenthesis that the term "non-medical men" is in this case not entirely correct, as the plan was surely suggested, advocated and accepted by important members of the Medical School, for instance the professors of pathology, physiology, anatomy, etc. However, this designation remains true to the extent that some of the medical men who advocated these radical changes in the department of medicine have practical knowledge only in the sciences closely associated with medicine, but not in the domains of clinical medicine itself. The report, however, acknowledges the fact that at present the placing of the clinical departments in the medical school on a satisfactory basis is one of the most pressing needs.

With this in view the council of Medical Education has appointed a strong committee of ten clinicians, who have had great experience in teaching and who are regarded as authorities in their special department and in medical education, to study this subject and to report to the next conference on medical education. . . . The medical school very properly demands that their clinical teachers be men who are recognized as authorities in their special fields both by the profession and by the community . . . whatever plan is adopted must make it possible for the clinical teachers to remain the great authorities in their special fields both in the eyes of the profession and in the eyes of the public.

The report of the council does not state directly that the present status of teaching in the clinical departments in the medical schools of this country is very unsatisfactory. It admits it, however, tentatively, when it states that the placing of this teaching on a very satisfactory basis is one of the most pressing needs. We have seen that the Johns

"Second: How important do you believe full-time positions in the clinical subjects are for a satisfactory connection between the school and hospital?"

[2] *Amer. Medicine*, 1902, Vol. 4, p. 146.

[3] *The Journal of the American Medical Association*, LXIII., 1914, 86.

Hopkins University already began to experiment with a cure for this unsatisfactory condition. The Council of the Medical Education finds this cure grotesque and defers its own therapeutic plans until the committee of ten clinicians has rendered its report on this problem. Now, we never ought to offer any treatment before we know exactly the nature of the ailment. What ails the instruction and instructors in clinical subjects in the medical schools in this country? I do not find that this phase of our problem, perhaps its most essential part, has been anywhere analyzed. I shall therefore attempt to do it here.

The report of the Council on Medical Education lays great stress upon the requirements that the clinical teachers must be "great authorities in their special fields both in the eyes of the profession and in the eyes of the public." If that would be really the main criterion of fitness, I would then say that professors of medicine of to-day fulfill, at least in most instances, their mission: they are great authorities in the eyes of the public and the profession; their offices are full and they are consulted by physicians and the sick from near and far. But are these authorities well-fitted to be heads of clinical departments? According to my way of thinking, I would say that in most instances they are unfit for these positions. Now let me give my reasons for this statement, which may sound a little too severe.

I wish to introduce my argument by the following two propositions, the correctness of which ought to be apparent to every one. (1) The proper preparation of practitioners of medicine is a very serious task; it is of great importance to the public as well as to the student of medicine himself, and ought, therefore, to be carried out as a *primary occupation* and in an earnest and conscientious manner. (2) No matter whether we take a progressive or a conservative stand in medicine, one and all must agree that the *student of medicine of to-day must be taught the medical knowledge as it is known to-day.* For this purpose let us look at the activities of any head of a clinical department, let us say, of internal medicine, who is, as the council demands, "a recognized authority in his field in the eyes of the profession and of the public"; let us see whether these activities comply with the above-mentioned self-evident requirements. Let us first scrutinize the history of one day of one of our noted professors of medicine. He has consultation hours every morning until noon; the waiting room is crowded (he is the "best diagnostician" in his town) and sometimes he has to remain in his office an hour or two longer. As a rule he has to accept a few bedside consultations with practitioners, which again takes up many hours of his time in the afternoon. He may even have to go out of town for consultations. At any rate, including the time given to his meals, etc., about ten hours of his day are easily accounted for by this activity. Then on account of his high social standing in the community, etc., functions have to be attended, for which his wife makes the engagements; dinners have to be attended and to be given; meetings of advisory boards and of all sorts of committees have to be attended. Then there are letters to be written or dictated, bills and other business matters to be looked after. No doubt that by these diverse obligations at least about three more hours of the day are consumed. We have thus far accounted for about thirteen hours every day of the professor's time. Now how much of his time is then left for teaching medicine to students and attending to the sick at the hospital? If I say three hours, I am sure it is exaggerated in most cases. But whether two or three hours, they are hours left over from a very busy active occupation, and the teaching is then done in most cases by a worn-out man bodily and mentally. It will be generally admitted that for nearly all teachers of clinical subjects private practise, with its commercial end, is the chief aim and occupation, while the teaching part is at best only a minor subject, and in not a few instances only an ornament and unmistakably a very desirable advertisement. I remember how years ago a noted surgeon, who was the professor of surgery at one of the best-known

medical schools, said to me: "They pay me a thousand dollars a year. The fools! I would pay them $5,000 for the professorship; it's worth more than $25,000 a year to me." What a deplorable condition! The teaching of the pure medical branches which, for the physician in the making, is the most important part of his medical education, should be carried on by worn-out men for whom it is invariably only a secondary occupation and often not much more than an ornament or an advertisement!

Now let us come to the second proposition. We have seen that the professor of medicine, who is considered an authority by the profession and the public, is so busy that very little time is left to him to carry on properly his duties as a teacher. Is there any time left him to study properly the advances which are continually made in medicine? Let us study the medical career of the best medical consultant and professor. He graduated in medicine at the head of his class, he served as an interne at a good hospital, he went abroad, where he learned the then newest things in medicine. After his return he soon became assistant to a leading consultant and a professor. For several years he made for his chief laboratory examinations with the older and newer methods of diagnosis, saw some of the chief's private patients, and was soon appointed adjunct at the hospital and instructor in the department of medicine of which his chief was the head. He saw some of the autopsies and compared them with the diagnoses; found time to read some of the newer medical literature, made himself several contributions to it; assisted his chief in preparing and giving the lectures and helped him in preparing a paper or two which had to be flavored with some of the newer things in medicine. Gradually he picked up a private practise of his own, which suddenly commenced to grow rapidly. He had to leave his chief, consultations began to come in, and in a short time he advanced to the position of attending physician in several hospitals, and perhaps also to the position of a clinical professor in his school. His reputation and his private practise grew, and with it grew his extensive personal experience; he was becoming indeed an excellent physician. But in exact proportion to this growth his spare time grew less and less, and with it grew fainter and fainter the first-hand acquisition of knowledge of the advances of medicine, which are going on in rapid strides all over the world. There was no longer any idea of doing some original work or of a patient study of communications on entirely new subjects which continually spring up in rapid succession. There was no real reading any more; perusing of some articles, glancing at abstracts, picking up one thing or another at meetings and discussions, had to take the place of study. Our authority is not an old fogy who does not believe in the truth of things which he does not know. On the contrary, he is a progressive man and knows how to get at the new things. With a growing income and with the cheapness of scientific labor, he learned early to surround himself with several young assistants, specializing in various directions. The morphology and the chemistry of the urine; the various morphological blood pictures, and the chemistry of the blood; the bacteriology of diverse diseases and the various immunity reactions; metabolic studies, phlebograms and cardio-electrograms, etc., our authority gets a report on all of them and is told of their possible significance by his various young assistants. Of course, his knowledge of these things as he picks them up is extremely superficial; they can be thoroughly grasped only by hard study. But our authority has to use, and uses, this superficial knowledge of new things in consultations at the bedside, in the lecture room and in papers and discussions at medical meetings.

To state it briefly: the store of more solid knowledge of the best clinical teacher, as we know him to-day, consists of that which he had acquired during his undergraduate and post-graduate studies and of the accumulated personal knowledge gained by long empirical observations at the bedside. Of the marvelous advances which are continually made in all

branches of medicine all over the world our clinical teacher has at best only a very superficial knowledge and ought not to be the man to teach them to the physician of the future.

The foregoing analysis shows, I believe, conclusively, (1) that the teaching of medicine to the future physicians is for nearly all the heads of clinical departments only a secondary occupation and in some instances it is not more than an ornament or a legitimate business advertisement; and (2) that most of the present heads of departments do not possess sufficient familiarity with the modern medicine to be the instructors of present-day medicine to the coming physician.

The source of this anomalous situation is to be found in the fact that heads of departments of medicine are chosen from the class of physicians who are primarily busy practitioners and consultants. They may be noted men in their line and perhaps are indeed all that the Council on Medical Education is laying stress upon, namely, "great authorities in their special fields both in the eyes of the profession and in the eyes of the public." But on account of that very virtue they are in such demand in their private practise that for years they could find no time to follow up seriously the rapid advances in medicine. For the same reason they are compelled to treat their vocation as educators in the science and practise of medicine only as a secondary occupation—which alone is bound to bring unsatisfactory results, even if our professors were well fitted to teach the medicine of to-day.

There is no doubt, then, that the present mode of instruction of clinical subjects is very unsatisfactory. Let us now examine the methods by means of which the anomalous situation could be mended best. I wish to present at first my own suggestion very briefly. I have pointed out before that the source of the evil is to be found in the fact that at present the heads of the departments are chosen from a class of very busy practitioners, for whom teaching is invariably only a secondary occupation. That fact points to the following plan as the most efficient remedy for our evil. Heads of departments should be chosen from a class of physicians who from the time of their medical graduation never ceased to be close students of their science, and for whom the study of and instruction in a chosen clinical subject constitutes their primary occupation. To the question, where can we get this class of physicians? my answer is: create it, or, more correctly expressed, accelerate its development, since a fairly good beginning has been made in the last few years. I shall return later to this suggestion and discuss it in detail.

In considering plans for correction, we ought to bear in mind that we are confronted not with one evil alone, but with two, namely, that (1) the present instructor in clinical subjects can not and does not give his best time to his calling as a teacher, and that (2) he has been for many years out of close touch with the advances in the medical sciences and is therefore unfit to teach them efficiently. Looking at our problem from this point of view, it is evident that the creation of "full-time" clinical professors will not cure the second evil. Suppose a large number of noted consultants, who are at present the professors of medicine in the various schools, resolve henceforth to make teaching their primary or even their exclusive occupation—will this resolution convert them at once into desirable educators, fit to teach efficiently modern medicine? There may be many things which they will have to learn from the beginning, just as much as their students, and at an age when learning is no longer an easy task.

The Johns Hopkins plan remedies both evils. That school was fortunate to be able to appoint as heads of the three chief departments of clinical medicine, men who always were close students of their branches of medicine, and who are willing to devote all their time to the teaching and the study of their subjects. As to the question, whether it is best that such teachers should have no private practise at all, opinions may differ, especially when this should be considered as a part of a general plan applicable to all medical colleges. As far as I know such a requirement

does not exist anywhere, even in Europe. But, as far as I know, the Johns Hopkins Medical School does not offer its new procedure as a general plan to be used in all other colleges. The Hopkins school follows lines of its own, and with great success. When that school was opened, about twenty-one years ago, the entrance requirements were made very high, indeed higher than at any place in the world, and at a time when most of the colleges in this country had very low requirements. The wisdom of that venture is to-day self-evident. Johns Hopkins Medical School is sending out a high type of medical men into teaching departments, into research institutes and into general practise. The part of the plan which does not permit the professor of clinical subjects to practise for private gain does not deserve to be designated as "grotesque," as has been done in the report of the Council on Medical Education. It probably originated in the desire to put the teachers of clinical subjects on a university basis, and thus maintain a university atmosphere in the medical school, an atmosphere which is essential to the mode of life of the scientific men of that school, and which is readily disturbed by the mode of life of a head of a department "who in a very limited amount of time devoted to practise could obtain for his service much more than the amount of such a salary."

However, it seems to me that this part may be well omitted from a plan which is devised to fit all or most good medical schools. The evils would be satisfactorily mended when study and teaching were the primary occupations of the head of a department. What he does with his spare time should not be our concern. We could not object, if he used it for some hobby; we should be rather glad, if he utilized it for practising medicine.

The Council on Medical Education says in its report that the Johns Hopkins plan "has not been well received by the clinical teachers and finds its supporters almost entirely among the laboratory men." The council has, as stated above, not yet made any definite suggestions; but it is very emphatic on the one point, namely, "whatever plan is adopted must make it possible for the clinical teachers to remain the great authorities in their special field both in the eyes of the profession and of the public." I wish to say here with emphasis that I have a profound admiration for the great work which the council has done in the short time of its existence. The results which it has achieved in the elevation of medical education of the United States are manifold: the general demand for higher entrance requirements; the weeding out of unfit medical schools; reducing in general the number of medical schools and the number of unfit practitioners in the United States; encouraging full-time professors for the purely scientific branches; demanding bedside instruction in clinical subjects and the creation of laboratories and the demand for laboratory work in clinical departments. The personal composition of the council has been usually good—authoritative indeed, as far as the above-mentioned premedical and medical education is concerned. But will the council as well as the committee which it has appointed remain authoritative and unbiased in their judgment also on the subject with which we deal here? We have seen that the two great evils of the present system consist in the facts that for our present heads of clinical departments instruction is only a secondary occupation and that on account of the extensive work which their primary occupation demands they are unable to follow efficiently the continuous progress of medicine. I have no doubt that the ten clinicians which make up the strong committee are "great authorities in their special fields both in the eyes of the profession and the public," that is, they are great practitioners and consultants. But for this very reason they are just the men who are not fit to be heads of departments in medicine. Will the members of this committee and the members of the Council on Education be unbiased enough to recognize the fact that being a celebrated consultant and being an efficient teacher of modern medicine are separate capacities which frequently exclude one another? The frequent repetition in the report of the council of the requirement

that the men to be chosen must be great authorities in the eyes of the public and the profession is, to say the least, disconcerting. To be a great authority in the eyes of the public is surely no evidence even of being an efficient consultant. Any one who is frequently mentioned in newspapers as having been called in consultation to treat this or that rich or noted man, or who has charged enormous fees, etc., stands as a great authority in the public eye and, I am afraid, not infrequently also in the eyes of the profession—in its present state of medical education.

I come now to a more detailed statement of my own suggestions. I shall say at the start that whatever the ideal plan may be, it should not be attained by revolutionary steps; *accelerated evolution gives better and safer results than revolution.* The changes should not be introduced abruptly; they should be gradually developed and adapted to the particular condition of each individual medical college. But these changes should in all cases be in the direction of one and the same ideal plan which could finally serve as a standard for all medical schools. Now as to this plan. I have given above a brief outline of it. But it dealt only with the head of a medical department. I wish now to consider the composition of the entire department. Generally it ought to be made up of the following four groups: (1) A head for whom this position should be his main occupation; (2) two, three or more paid scientific assistants for whom this position should also be their chief occupation; (3) several professors and associate professors, etc., for whom these positions will be secondary occupations, their chief occupation being their private consultation or family practise; some of these may receive moderate salaries; (4) an unlimited number of unpaid volunteer assistants. I should say here that all these positions should be appointments, limited variously to varying periods of years.

The head should give about eight hours a day to this, his main calling, and they should be his fresh hours, say, from 8 A.M. to 4 P.M. After these hours he may do with his time as he pleases. He may accept private consultations at his office or at the bedside and keep the fees. *But he should have no private patients at the hospital in the department of which he is the head.* If this hospital has paying patients, all the income from these patients goes to the budget of the hospital. He should not accept consultations for the first eight hours of the day, and he should make it his business to avoid spectacular consultations. He should do his best to be appreciated by the best of his profession, but to do also his best to avoid standing continuously in the public eye. *He should help to make medicine a science and its teaching a serious business, and by his behavior he should assist in the efforts to deprive the practise of medicine of its commercial aspect.* For a head of a department the first two reappointments should be for five years only; a further reappointment, if it takes place, should be until age limit. This will serve as an efficient corrective against misuse of position or mistaken election. The salary of a head of a clinical department should at least equal the highest given at that university.

The election to headship must be based upon evidence that for the past years the appointee has been continuously a close student of modern medicine and showed efficiency in teaching, as well as in research, in the scientific and practical fields of medicine. The work of the department should be conducted with the aid of all three classes or groups, but especially with the aid of the scientific assistants.

These shall be elected from graduates who have given evidence of possessing higher abilities and ambitions, and who had one year service in a good hospital and one year laboratory work in the science of medicine. They shall be appointed for three years with salaries varying from $1,000 to $2,500. During the first period their entire time should belong to the department; when reappointed, however, for a second period, they should be required to give only about eight hours a day to the department and use the balance of their time for the acquisition of some kind of a pri-

vate practise. The senior assistant should serve as adjunct to the head. It should be the duties of these assistants, besides conducting the routine work of the department with all its ramifications, to take up successively, every six months of these three years, special parts of medicine for a special study, so that at the end of the three years they would have acquired an intimate knowledge of the entire field of their department. They should also acquire successfully a fair knowledge and technique of all or most of the sciences allied to medicine. They should follow closely the new steps made in medicine and the allied sciences and test the reliability and practical applicability of new statements. I shall not enter into further particulars of their duties, which in the main should be guided by the head of the department.[4]

When these scientific assistants have served from eight to ten years, they will be in most cases well qualified to investigate and teach modern medicine from a scientific as well as from a practical point of view. That is the new class of physicians, of which I spoke above, which should be created and from which the new heads of clinical departments should be chosen. If a number of high-grade medical schools would accept this part of the plan, in eight or ten years the country would be provided with a group of a higher type of clinicians. They will then work for the further development of this new type and our problem would find a permanent solution.

The third group should consist, as stated before, of professors, associate professors, etc., who should teach practical medicine at the bedside and for whom the teaching part may remain, as it is now, their secondary occupation, their primary occupation being private practise. They should be appointed for periods of five years and receive some remuneration. They should be selected from the consultants and practitioners of the town where they are recognized for their ability and efficiency. They should teach medi-

[4] The problem of research which ought to occupy the clinical departments, and the methods of teaching which they ought to follow are too extensive subjects to discuss them here. I wish, nevertheless, to append here the following brief remarks:

1. Recent writers were emphatic in their statements that diagnosis and therapeutics are the exclusive fields for clinical research. When a clinician begins to study pathological and physiological problems it is time for him, they say, to leave clinical medicine and become a pathologist or a physiologist. This is a fundamental error and an unfortunate misconception of the scope of medicine. Diseases are experiments made by nature which great clinicians ought to try to interpret not merely by pressing them into facts, views or classifications found or put up by others, but also by original, broad views and illuminating conceptions of their own, if they are the brainy scientifically well-trained men which they ought to be. Medicine had to wait long for the appearance of clinicians like Graves, Addison, Gull and Kocher and Minkowsky to bring to light new forms of diseases and to shed light upon the normal function of apparently obscure organs. If clinical medicine will attract real brainy men who had a thorough training in the methods of investigations in the adjoining exact sciences and who would choose medicine as their field of investigation, a flood of light would be thrown in rapid order upon the nature and the course of the functional processes in disease and in health. 2. Even in this, more scientific part of the department, the practical education of the students must be foremost in the mind of the teacher. They should be taught, here, indeed, the medicine as it is known all over the world today. But newer things ought to be tested at the department for their reliableness and usefulness and ought to be made handy and practical, before they are handed over to the students. All students ought to be trained, in the first place, to become efficient practitioners. They will have to see many patients in one day and will have to act quickly and efficiently. New things appear daily; some are very complicated and some have only a temporary place in practical medicine. By loading the minds of the average student (and practitioner) indiscriminately with the "newest things" in medicine, we create there a haze which interferes with the promptness of the practical activity. Departments of medicine which will seriously and in an unpreoccupied manner test all new things before putting their stamp upon it, will act as very meritorious clearing houses for the practise of medicine.

cine from the point of view of their rich, personal experience.

The fourth group, the volunteer assistants, should consist of younger men of ability of the practitioners' class. Officially they should work with and under the last-named group of teachers, but suitable men should be admitted for special purposes to the laboratories of the scientific staff. Under certain proper circumstances one or the other man of this group may be appointed to the staff of scientific assistants. The appointment of volunteer assistants should be for two years, and if after one reappointment they are not found deserving of advancement to the regular staff, they should not be reappointed.

As far as teaching is concerned, all parts should work as a unit, regulated chiefly by the head of the department.

The necessity for reappointment will serve, as stated above, as a valuable controlling factor; the power of appointment and reappointment should therefore be exercised with great care. I would suggest the following distribution of power. Heads of departments and full professors should be appointed, or reappointed, by the university; all other members of the staff should be appointed or advanced by the members of the medical faculty. In appointing and reappointing scientific assistants the head of the department should have at least three votes.

A head of a department who does not wish a reappointment, or is not reappointed, after ten years' service, shall have the right to be transferred to the practical department with the title professor—unless there are potent reasons against such a transfer. This, in conjunction with the privilege of having some private consultations at his own time during his occupancy of the headship, will compensate the head of a clinical department for the failure to obtain an appointment for life.

As to the relations of hospitals to the teaching department I can be briefer. There must be one hospital which is devoted exclusively to the teaching and study of clinical branches of medicine. While it may have laymen as trustees and a medical superintendent with the necessary clerical staff for the conduction of the business of the hospital, the actual management of its inside affairs should be exclusively in the hands of the medical faculty, and the inside affairs of each department should be exclusively or essentially in the hands of its head. This hospital should not have many private rooms for well-to-do patients, and, as stated above, they should not be used for private patients of the head of the department or any other member of the faculty. The income derived from the treatment of well-to-do patients in private rooms should go to the funds of the hospital.

There ought to be at least one other hospital at the disposal of the medical school which may have many private rooms. Here the practical staff of the school will teach at the bedside—in addition to their right to send patients to and teach at the school hospital—and here the consultants and practitioners belonging to the school may treat their private patients in the private rooms.

The students of medicine will have then a chance of learning predominantly modern scientific medicine at the one, and predominantly practical medicine with a mixture of art at the other, hospital. He will then be able to make his selection as to his future career, according to his natural inclinations and preceding impressions, whether it be scientific medicine with its elevating atmosphere, or active practise and all that goes with it.

S. J. MELTZER

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

RESEARCH AND TEACHING IN THE UNIVERSITY[1]

1. No verifiable evidence has been published which proves how research affects the quality of university and college instruction.

2. I believe that research work usually improves the teaching of the instructor, both in the subject in which the research is conducted

[1] Answers to twenty-one questions addressed to the writer by Messrs. William H. Allen and E. C. Branson, directors of a survey appointed to report on the work of the University of Wisconsin.

and in other subjects. It, however, depends on the man and the circumstances. Some men of character and ability may use their time most profitably in teaching. On the other hand, it may be the duty of some instructors to devote themselves mainly to research, even though they are therefore compelled to neglect somewhat their students. It is the duty of the university professor or instructor in equal measure to advance knowledge, to teach students and to serve the public. He should undertake what he can accomplish to best advantage.

3. Research affects methods of instruction directly in so far as it leads the instructor to think more independently and to gain command of his subject instead of depending on text-books. The principal arguments, however, for encouraging instructors to do research work are: (1) It is the business of the university to advance knowledge and to train men to advance knowledge; (2) Better men can be obtained if they are permitted to do research work, and (3) This gives an objective criterion of their ability.

4. Whether the teacher benefits most by research which he conducts alone, by research in which he is assisted by students, or by supervising the research of students, would depend on the circumstances of the case. An efficient professor would probably use the three methods. Perhaps on the whole the 'prentice method is the most desirable and the most economical in the production of scientific results.

5. The extent to which a student is helped by assisting the instructor depends on the kind of work he is set to do, the amount of freedom he is given and his understanding of the problem on which he is working.

6. The student who engages in research work uses the correct method of learning by mastering one subject and relating other knowledge to it; he gains in interest, in independence and in power of initiative, and he learns how to do research work.

7. The result of the instructor's research would usually be to increase his enthusiasm in teaching, which would doubtless apply more directly to the subject which he is investigating and to advanced classes, but it would tend to hold to a certain extent in all cases.

8. Both scholarship and research are important, but I regard the latter as the more important.

9. It is desirable for the student to choose some special subject for work and to connect his other interests with that subject.

10. It follows from this that in preparation for the master's degree or the doctor's degree it is best to require complete mastery of some subject, other knowledge being related to this, rather than to study the whole field of science as it might be represented in a text-book. I regard the preparation of a dissertation as usually desirable.

11. There is, in my opinion, no fundamental difference between adding to knowledge and applying knowledge in new ways. The distinction is between discovering or applying new methods and applying old methods in the old way. The professional school should be on the basis of the university, not of a trade school.

12. I regard knowledge as of value only in so far as it is useful. It may, however, be useful as religion or art is useful. All knowledge is likely to be of use, and the investigator is justified in carrying on investigations the usefulness of which can not be foreseen. I myself prefer investigations the immediate or remote usefulness of which is evident, though an element of danger enters when the utility may be a financial gain to the investigator. It would be desirable to pay the professor an adequate salary and let any money he earned by the application of science go to his department.

13. An instructor in chemistry is usually more usefully employed, even as regards his teaching ability, in conducting chemical investigations than in research as to how to teach chemistry. However, one of the advantages of research is that it leads the instructor to consider and adopt improved methods of teaching.

14. Scientific research is a different problem from helping students. As I understand it,

the object of the questions is to inquire whether the instructor is likely to help students more if he carries on research than if he does not, and my reply is in the affirmative, with the qualification that this is not based on definite knowledge and that much depends on conditions. There is probably a high correlation between ability to carry on research and ability to teach, and the productive scholar or scientific man is more likely to have a beneficial influence on the student than a professor who does nothing but teach and attend athletic events.

15. The stimulating effect of research is doubtless to a large extent due to professional recognition, and in return professional recognition stimulates research. The university should consequently promote the means of publication by professors and instructors, pay their expenses to attend scientific meetings, invite scholars and scientific men from other institutions to lecture and give courses, arrange for the exchange of instructors and the like.

16. It is more desirable for instructors in the department of education to study methods of instruction than for instructors in other departments to do so.

17. The more advanced a student is, the more desirable is it that his instructors should be engaged in research work. This would also be desirable even in elementary schools, but it is not at present feasible to obtain teachers competent to do research work or to pay them. Perhaps if salaries were more adequate all the way from the elementary school to the university, it might be possible to obtain men competent to do research work, to the great benefit of the students and of the world.

18. Under existing conditions the college or university which fails to provide for research work by its instructors is likely to have mediocre teaching. The better men tend to go to institutions where they will be encouraged to do research work and those who stay are apt to adopt the attitude of the schoolmaster rather than that of the professor. The university or college which does not regard the advancement of knowledge and public service as part of its functions has small claim to public support or private gifts, and is likely to deteriorate in all directions.

19. The amount of productive scholarship and research work conducted in America has increased many fold since the introduction of graduate work in the universities in the seventies, and at present three fourths of our productive scientific men are supported by our universities and colleges. The majority of our leading scientific men are connected with a few universities doing graduate work.

20. It is obvious that if the instructor devotes all his time to teaching, he can not do research work. The science in which America was most productive, prior to the introduction of the modern university, was astronomy, in which subject a large amount of undergraduate teaching was not required. Those men doing the most valuable work do not devote the larger part of their time to undergraduate or class teaching. A professor can teach by example as well as by lecturing.

21. I doubt whether most administrative work by instructors has a stimulating and broadening effect on their teaching. One of the chief dangers to the American university is that honor, influence and salary are given to administrative officers instead of to the productive scholars and men of science who are the university.

J. McKeen Cattell

SECTION OF ZOOLOGY OF THE AMERICAN ASSOCIATION

Section F—Zoology—of the American Association for the Advancement of Science will hold its annual meeting at Philadelphia, December 29, 30 and 31, in conjunction with the American Society of Zoologists and the American Society of Naturalists. All sessions will be held in the lecture room of the zoological department of the University of Pennsylvania. A joint symposium has been arranged for the afternoon of Thursday, December 31, with the following program:

E. G. Conklin—The cultural value of zoology.

C. B. Davenport—The value of scientific genealogy.

G. H. Parker—The coming problems of eugenics.
Stuart Paton—Modern aspects of the study of the mind.
H. F. Osborn—The museum in the public service.

The address of Dr. Mayer, the retiring Vice-president of Section F, will be given at the close of the Naturalists' banquet, Thursday evening, December 31. Dr. Mayer will speak with lantern illustrations upon the work of the Tortugas Laboratory.

As under the rules of the American Association the officers of national societies take charge of the program of joint meetings, the program of the Philadelphia meeting will be in the hands of the officers of the American Society of Zoologists. All titles and abstracts of papers therefore should be sent to Professor Caswell Graves, Johns Hopkins University, before the first of December. But members of Section F, American Association for the Advancement of Science, who are not members of the American Society of Zoologists, may send them to H. V. Neal, Tufts College, Mass.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its autumn meeting at the University of Chicago on December 7, 8 and 9.

THE Association of German Scientific Men and Physicians will hold no meeting this year.

THE past and present members of the scientific staff of the Rockefeller Institute for Medical Research gave a dinner at Delmonico's to Dr. Simon Flexner on October 16, in celebration of the tenth anniversary of the opening of the laboratories of the institute under his direction. The members of the board of scientific directors and of the board of trustees were present but the dinner was not public. Dr. S. J. Meltzer presided; a short address, engrossed on parchment and signed by the members of the staff, was read and presented to Dr. Flexner. The following spoke: Dr. W. H. Welch, Mr. F. T. Gates, Mr. John D. Rockefeller, Jr., Dr. Peyton Rous, Dr. Hideyo Noguchi, Dr. F. R. Fraser, Dr. Jacques Loeb, Dr. Rufus Cole and Dr. Flexner.

THE *Observatory* states that among the visitors to the Royal Observatory, Greenwich, during September, were Professor and Mrs. W. W. Campbell, Professor H. D. Curtis and party of the Lick Observatory, and Professor C. D. Perrine and Mr. Mulvey, of the Cordoba Observatory. Both parties were returning from eclipse expeditions in Russia, neither of which, unfortunately, met with success, owing to cloudy skies. The Lick Observatory party was stationed near Kiev, practically on the central line, while the Cordoba observers were near Theodosia with Professor and Mrs. Newall.

DR. ALBRECHT PENCK, professor of geography at Berlin, and Dr. Otto Maas, professor of zoology at Munich, who attended as guests the meeting of the British Association for the Advancement of Science in Australia, are, according to a press despatch, detained in England. Dr. Otto Lutz, professor of biology in the Institute Nacional de Panama, the author of an article in the last number of SCIENCE, is held there as a prisoner of war.

LEAVE of absence has been granted by the trustees of Princeton University to Professor Pierre Boutroux, of the department of mathematics, who is in the French service, and to Professor Joseph H. W. Wedderburn, of the same department, who has returned to England to enlist in the British army.

DR. ROBERT W. GEDDES, professor of anatomy in McGill University, has been called by the British war office to take command in one of the home regiments. Dr. Geddes was a reservist of the British army, having served with distinction in the South African War. He became professor of anatomy in McGill in 1912.

THE New York Section of the American Chemical Society has appointed a committee to examine into the feasibility of expanding the manufacture of chemicals and dyestuffs in the United States. This committee is composed of H. A. Metz, I. F. Stone, J. B. F. Herreshoff, David Jayne, J. M. Matthews, Allen Rogers and B. C. Hesse, chairman.

A cooperative agreement has been entered into by the University of Illinois and the U. S. Department of Agriculture, whereby all of the demonstration work done by the department will be in cooperation with the University of Illinois and under the management of the same organization that administers the Lever bill. Pursuant to this plan of cooperation, Mr. W. F. Handschin, now of the animal husbandry department of the university, has been appointed state leader in charge of the county advisory work, both under the Lever bill and the cooperative relations with the department.

Dr. L. A. Bauer gave an illustrated lecture before the Franklin Institute, at Philadelphia, on October 21, his subject being "The Earth, a Great Magnet."

Professor J. M. Aldrich, of the U. S. Bureau of Entomology, who was for many years a professor of geology in the University of Idaho, gave a lecture at the University of Illinois on October 14 on "Western Salt Lakes and Their Inhabitants."

Sir J. J. Thomson delivered his presidential address to the Physical Society of London on October 23, the subject being "Ionization."

In connection with the London County Council's plan of indicating the houses in London which have been the residences of distinguished individuals, a tablet has, as we learn from *Nature*, recently been erected commemorating the residence of Benjamin Franklin, at 36 Craven Street.

The scientific library which Professor Newton H. Winchell gave to the University of Minnesota is estimated to be worth six thousand dollars. It is a valuable collection of books and serial publications in geology, archeology and related subjects, collected by Professor Winchell during his long life engaged in scientific work.

A portrait of the late Dr. Reginald Heber Fitz, by Mr. I. M. Gaugengigl, of Boston, has been presented to the Harvard Medical School by more than one hundred former associates and pupils. At the presentation made at a full meeting of the faculty of the school, President Lowell presided and the gift was formally made to the university by Dr. Harold C. Ernst. Dr. Fitz was professor in the Harvard Medical School from 1873 to 1908.

Bernard Richardson Green, civil engineer, superintendent of the Congressional Library building and grounds, died on October 22, aged seventy-one years. Mr. Green was born at Malden, Mass. He was graduated from the Lawrence Scientific School, of Harvard University, in 1864. For fourteen years subsequently he was engaged with officers of the United States Corps of Engineers in constructing permanent seacoast fortifications in Maine, New Hampshire and Massachusetts. Since then he had been in charge of the erection of public buildings in Washington, including the State, War and Navy Buildings, the Washington Monument, Army Medical Museum and Library, United States Soldiers' Home, the Library of Congress, the Washington Public Library and the National Museum Building.

Dr. Hans Halle, assistant in plant physiology in the University of Munich, has died as the result of wounds received in the war.

The death is announced of Dr. Maximilian Reinganum, professor of physical chemistry, in Freiburg i. Br.

On account of the situation in Europe and America created by the war, the executive committee for the Second Eugenics Congress has decided that it will be impossible to hold the proposed congress in New York City in September, 1915. The existing organization will be maintained, pending the reestablishment of settled conditions, when the committee will determine upon a new date. The executive committee hopes for the continued interest of those who have consented to serve as members of the several committees and as officers of the congress.

Since the European war broke out Holland has increased its appropriation for the Panama-Pacific International Expedition from $100,000 to $400,000; Argentine from $1,300,000 to $1,700,000. France, which appropriated $400,000 for her participation, has sent word that there is no change in her plans. Japan is pre-

paring a comprehensive national representation and appropriated $600,000. Thirty-nine foreign nations will participate in the exposition.

In the *Observatory* the monthly notes entitled "From an Oxford Note-book" begin as follows: "There is but time for a hurried note or two to catch the mail, for the upheaval in Europe has transmitted waves of minor disturbance to the Antipodes, which have eliminated the small intervals of leisure originally allowed us by Australian hospitality. The news of the war reached us by wireless telegraphy a day or two before our landing, with an effect on a company containing representatives of many nations which can well be imagined. Sir Oliver Lodge, the retiring president, at once struck a note which has been resonant ever since; rising from his chair at dinner he remarked that science knew no politics, he called attention to the presence of various distinguished foreign guests among us, and took the opportunity of drinking their very good health. The brief simple words were received with a burst of applause. When we landed and were most hospitably entertained at Perth, the same spirit was abroad; at the conferring of honorary degrees at Adelaide (and afterwards here at Melbourne), the German visitors were specially and heartily applauded—and whenever Germany was mentioned, it was to speak of all that it had done for science. Finally, it was made clear from the first that the main desire of the Australian people was to carry through with as little disturbance as possible the splendid program they had arranged for us. Balls were, of course, turned into receptions, and the National Anthem was a notable feature of all the earlier gatherings; but the scientific part of the program has been up to the present fully carried out."

The magnetic survey vessel, the *Carnegie*, arrived at Brooklyn on October 21, having completed a cruise of about 10,000 miles this summer in the North Atlantic Ocean. *En route* from Hammerfest, Norway, to Rejkiavik, Iceland, she reached the latitude of 79° 52′ north, off the northwest coast of Spitzbergen. Mr. J. P. Ault, of the Department of Terrestrial Magnetism, was in command of the vessel; he was assisted in the scientific work by Dr. H. Y. W. Edmonds, and by Messrs. H. F. Johnston, I. Luke and N. Meisenhelter.

A cablegram from Buenos Ayres states that Sir Ernest Shackleton's Antarctic steamer *Endurance* is coaling at Montevideo, Uruguay. She reports that she had a bad voyage. She was delayed to such an extent that the coal became exhausted, and she was forced to burn her spars to make port. Sir Ernest Shackleton and the members of his staff are said to be well. They expected to leave Buenos Ayres for the Antarctic region about October 23, and to be able to arrive in the Weddell Sea about the end of November. Sir Ernest said that if he is compelled to go into winter quarters at some point on the Weddell Sea he believes that he may be unable to communicate with the civilized world before about March, 1916.

The American Genetic Association, Washington, D. C., offers two prizes of $100 each for two photographs, one of the largest tree of a nut-bearing variety in the United States, and one of the largest broad-leaf tree which does not bear edible seeds. In the first class, for example, are included trees such as chestnut, oak, walnut, butternut and pecan; and in the second, trees such as elm, birch, maple, cottonwood and tulip poplar. No photographs of cone-bearing trees are wanted, since it is definitely known that the California big trees have no rivals among conifers. At a later time the association may take up the same question as between the various kinds of conifers, such as pines, spruces, firs, cedars and cypresses. The announced purpose of the Genetic Association is to bring about the dissemination of seed or stock of the best specimens, when found, to demonstrate, if possible, the value of heredity in tree growing. The contest ends on July 1, 1915.

The non-resident lecturers in the graduate course in highway engineering at Columbia University appointed for the 1914–1915 session are as follows: John A. Bensel, New York state engineer; Edward D. Boyer, cement and con-

crete expert, The Atlas Portland Cement Company; Sumner R. Church, manager, research department, Barrett Manufacturing Company; William H. Connell, chief, bureau of highways and street cleaning, Philadelphia; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey; Charles Henry Davis, president, National Highways Association; Arthur W. Dean, chief engineer, Massachusetts Highway Commission; John H. Delaney, commissioner, New York State Department of Efficiency and Economy; A. W. Dow, chemical and consulting paving engineer; H. W. Durham, chief engineer of highways, Borough of Manhattan, New York; C. N. Forrest, chief chemist, Barber Asphalt Paving Company; Walter H. Fulweiler, chief chemist, United Gas Improvement Company; D. L. Hough, president, The United Engineering and Contracting Company; William A. Howell, engineer of streets and highways, Newark; Arthur N. Johnson, highway engineer, Bureau of Municipal Research, New York; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York; Philip P. Sharples, chief chemist, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemist; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, New York; George Warren, president, Warren Brothers Company.

Greenhouses for work in plant pathology and plant physiology are now in process of erection and will be ready for use within a few days at the University of Illinois. These comprise 12 greenhouse rooms to be equally divided between the two subjects. Greenhouses are usually provided with ample heating arrangements but these new houses of the university will also have in connection an ample refrigerating plant so as to enable such sections of the house as may demand it to be cooled to the desired point. There is provision, such that any desired area may be isolated, "quarantined" from other sections and also for regulating the humidity and other factors of environment in such way as may be necessary in studying disease resistance, immunity, etc.

Secretary Lane has issued an order designating as nonirrigable under the 320-acre homestead law more than a million acres of land in the state of Oregon. The effect of this order, which becomes effective November 10, is to make such of these lands as are vacant and subject to entry available to be taken up as enlarged homesteads of 320 acres each. Those having within the designated area entries of 160 acres upon which final proof has not been made may apply to enlarge their homesteads to 320 acres by taking up an additional 160 acres of any of the designated land which is surveyed, vacant, nontimbered, etc., and which adjoins their present entries.

The Panama-Pacific International Exposition is provided with its own railway system, which runs through all the exhibit palaces and throughout the exposition grounds, connecting with the freight ferry slip near the Palace of Machinery. Cars may be switched into the exhibit palaces and exhibits unloaded in the space in the palaces which they are to occupy. Under the classification of exhibits each group and class of exhibits at San Francisco is assigned a certain area in the exhibit palaces, an arrangement which simplifies to an extraordinary extent the actual placing of exhibits. When an exhibitor makes application for exhibit space his application automatically falls into one of the eleven different exhibit departments and automatically will be placed in one of the eleven exhibit palaces. Consolidation agencies are established in the east and exhibits routed direct to the exposition grounds. Whenever possible exhibits are made up in carload lots. More than seventy thousand tons of exhibits will be shown at San Francisco, involving a freight charge of more than $3,000,000. Exhibits brought from different portions of the United States will be returned without charge to the exhibitor, provided they have not changed ownership. When a car load of freight reaches Oakland it is barged across San Francisco bay to the exposition freight ferry slip, or, if shipped via San Francisco Peninsula, it will come by the

Belt Line directly into the exposition grounds. When foreign exhibits reach San Francisco bay by steamer they are barged to the exposition freight ferry slip.

IN Virginia there are 700 school and civic leagues organized in the country school districts by the Cooperative Education Association, which is a citizens' organization working in conjunction with the State Department of Education. A school and civic league is "a social club, school betterment association and chamber of commerce set down in a country neighborhood and holding its meetings in the schoolhouse. Officers are elected, meetings are held monthly or fortnightly, and the teacher is a leading spirit in all activities." It is a means of community education for practical citizenship adapted to rural conditions and needs. In addition to musicals, spelling bees, and other social activities, discussion and debate of public questions, primarily of local interest, occupy the meetings. The Cooperative Education Association sends to each league programs on such questions as health, good roads and better farming. A home reading course has been established, based on a text-book on some rural subject and supplemented by bulletins from the several state departments and from the College of Agriculture. Upon the completion of the course members are awarded certificates. The civic training afforded by the leagues comes largely, however, through activity in behalf of better community conditions. One league last year raised $2,500 for the improvement of the roads leading to the school, and this year the good roads meeting held in a one-room school started a movement for an automobile road over 100 miles in length. The improvement of the school itself is, of course, one of the chief interests of the leagues. In 1912–13 they collectively raised $65,000 which was expended for libraries, pictures, pianos, window shades and other improvements. In a sparsely settled section of Charles City County, which until a year ago had no school facilities, a league was formed, an old farm building was rented and furnished with a few chairs and a table, and the school trustees were requested to supply a teacher. Interest increased and finally a model one-room school building was erected, partly by public funds and partly by money raised by the league. Many high schools in Virginia have been built in just this way.

UNIVERSITY AND EDUCATIONAL NEWS

THE corporation of Yale University has approved plans for the new pathological laboratory of the Medical School, in connection with the New Haven Hospital. This building is to be called the Anthony N. Brady Memorial, and is a gift of members of the Brady family.

THE Baltimore Association for the Promotion of the University Education of Women again offers a fellowship of $600 for the year 1915–16 available for study at an American or European university. Applications must be in the hands of Dr. Mary Sherwood, chairman of the committee on award, before January 1, 1915.

THE trustees of Princeton University have increased the tuition for regular students from $160 to $175 a year, beginning September, 1915. The remission of tuition which is granted to needy students has been increased from $100 to $115.

BEGINNING this autumn only the degree of bachelor of arts will be awarded to students of the college of the University of Pennsylvania, the degree of bachelor of science in the arts course having been discontinued.

PROFESSOR A. N. WINCHELL, of the University of Wisconsin, is trying the experiment of teaching the microscopic study of minerals and rocks by correspondence, under the auspices of the Extension Division of the University. Each student must be equipped with his own petrographic microscope and thin sections.

THE Aix-en-Provence University has invited the Belgian universities to send their faculties and students to Aix, offering to provide free lodging for the students. The university has asked the minister of education for the privilege of granting degrees to the refugee students.

Dr. T. E. Hodges, president of the University of West Virginia, has resigned to become a candidate for congressman-at-large.

Professor James William Toumey has been elected director of the Yale School of Forestry for five years, in place of Henry S. Graves. Professor Toumey has been acting director during Professor Graves's absence as United States forester.

Professor M. A. Rosanoff, for the past seven years director of the department of chemistry in Clark University, has accepted a professorship of chemical research in the Mellon Institute of Industrial Research and the graduate school of the University of Pittsburgh. Dr. Rosanoff's students have resigned fellowships at Clark and have followed him to Pittsburgh.

Dr. Homer F. Swift has been appointed associate professor of the practise of medicine in the College of Physicians and Surgeons of Columbia University in succession to Dr. Theodore C. Janeway, now of the Johns Hopkins Medical School.

Dr. Alwin M. Pappenheimer has been appointed professor of pathology in the College of Physicians and Surgeons, Columbia University, to succeed Dr. James W. Jobling, who has become professor of pathology in Vanderbilt University.

In the University of California Dr. Walter Lafayette Howard, since 1905 professor of horticulture in the University of Missouri, has been appointed associate professor of pomology. Dr. Jacob Traum, until recently of the staff of the division of pathology of the Bureau of Animal Industry of the United States Department of Agriculture, has been appointed assistant professor of veterinary science, and will devote his time to investigations in regard to tuberculosis in the domestic animals. Roland S. Vaile, until recently collaborator in the United States Bureau of Entomology, has been appointed assistant professor of orchard management. He will be attached to the Graduate School of Tropical Agriculture at Riverside.

At the Massachusetts Institute of Technology in the department of mechanical engineering, E. W. Brewster and Arthur F. Petts have been named assistants, and Henry M. Wylde, Robert T. Gookin and Walter Haynes, assistants in inorganic chemistry, food analysis and electrical engineering, respectively. Dr. Charles A. Kraus has resigned as assistant professor of physico-chemical research.

DISCUSSION AND CORRESPONDENCE

EVOLUTION BY SELECTION OF MUTATIONS

Hugo de Vries, in his Brussels address delivered last January and printed in Science of July 17, with an annotation by the author replying to a criticism of his theory by Edward C. Jeffrey, objects to evolution by selection of fluctuating variation on the ground that this is too slow a process for the length of geologic time.

He does this without offering any evidence that evolution by selection of mutations would be any faster process. He admits that "it is hardly probable that these jumps are numerous in a state of nature as it now surrounds us."

Is there any more presumption in favor of a more rapid rate for evolution proceeding by jumps separated by long intervals from each other than by evolution proceeding by constant though imperceptible steps?

Until we are in possession of such quantitative data we are not in a position to affirm how much change may or may not take place in organisms in a given period of time.

Croll, I think it was, offered a word of caution here. It was to the effect that no one was in a position to say offhand what might or might not take place in a million years.

It has always seemed to me that Herbert Spencer pretty effectually answered the "not-time-enough objection" to evolution, even by the slow process of imperceptible change in organisms; by a comparison of ontogeny with phylogeny and the drawing of a conclusion in accordance with the simple "rule of three."

Taking the development of man in his individual history of 40 weeks from germ cell to fully developed human being, as an epitome of the development of the animal kingdom

from protozoan cell to highest vertebrate in the course of geologic ages, he let 40 weeks (reduced to hours) represent geologic time—say 20 or 40 million years. For the third term in the proportion he took the number of hours it was necessary to observe the embryonic development in order to detect an appreciable change, and obtained for an answer as the fourth term a number in years which was much longer, even when the shortest lengths of geologic time were taken, than our historic period.

So that it was clear there was plenty of geologic time for evolution to proceed at a pace so slow that it could not be detected within the historic period and still accomplish its perfect work.

When it comes to attempts to estimate geologic time in years it seems to me that most persons must agree that they are not very satisfactory. This is particularly so with those of the physicists who have assumed as a basis for their calculations an origin for our planet, no longer looked upon with much favor in the light of the facts which support the planetesimal hypothesis. These calculations have also been largely invalidated by discoveries relating to the radio-activity of matter.

Of all geologic time estimates, those based upon rate of denudation, and its correlative—the rate of deposition of stratified rocks, seem least unsatisfactory. When these methods are applied to precambrian time it is admitted they amount to little more than wild guesses.

And yet we know that evolution was well on its way before the beginning of Cambrian time.

Walcott has brought to light in the Canadian Rockies abundant evidence of a rich and by no means lowly organized marine fauna at the very beginning of Cambrian time.

He and others estimate that at least 90 per cent. of the total evolution to the present had taken place before the Cambrian period.

Le Conte, even before he had had the benefit of these discoveries, was impressed with the high type of the Cambrian faunas.

His memorable words in this connection are:

When the curtain goes up on geological history at the beginning of the Cambrian Period we find practically all the subkingdoms of the animal kingdom present and ready to answer to the roll call.

In the light of these facts what vistas of practically unrecorded geologic time filled with evolutionary process are opened up to us!

Bold indeed is he who from a rate of development predicated upon that observed during the brief span of the historic period would assert that geologic time is too short for a gradual evolutionary process.

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POTASSIUM CYANIDE AS AN INSECTICIDE

READING the article of Professor Fernando Sanford in the October 9 issue, I would add that I have found potassium cyanide very effectual in killing ants in lawns, and it does its work without killing the grass. A half ounce in 6 to 8 quarts of water applied with a sprinkling pot is enough for a nest 18 or 20 inches across.

W. G. BLISH

SCIENTIFIC BOOKS

Dialogues concerning Two New Sciences. By GALILEO GALILEI. Translated from the Italian and Latin into English by HENRY CREW and ALFONSO DE SALVIO, of Northwestern University, with an introduction by ANTONIO FAVARO, of the University of Padua. New York, The Macmillan Company. 1914. Pp. xxi + 300. Price $2.00 net.

In these dialogues Galileo presents the results of his investigations in mechanics and physics. His representative, Salviati, speaking either for himself or as the reader and expositor of the manuscript of a certain unnamed academician—of course Galileo once again—is the principal speaker, and the source of most of the valuable original ideas. Sagredo, the more learned of the other two interlocutors, occasionally contributes something of importance. Simplicio, as an interested layman, raises the objections which would occur to such a man, and gives occasion for the introduction of alternative ex-

planations or illustrations. In presenting such new and revolutionary views as these of Galileo the dialogue form is really the best that could have been used. It enables the author to consider the questions he treats from various points of view and to answer objections or confirm and enlarge upon his propositions, and to do this in an interesting way. The literary skill with which Galileo uses the advantages which the dialogue affords him is remarkable.

The discussion of the first and second day is devoted to the subject of the resistance which solid bodies offer to fracture. On the first day the talk is not very systematic. Salviati introduces the subject by calling attention to a fact known to all practical men, though seemingly forgotten by the philosophers, that a large structure built of the relative dimensions of a small model is not of the same relative strength, but is always weaker; and declares his intention of proving the relations which must obtain among the dimensions of such structures in order that they shall be of equal strength; but he soon drifts off into other matters. Not to mention them all, we find in this book a discussion of the *horror vacui,* in which is described the famous experiment which showed that a suction pump will not lift a column of water more than eighteen cubits, and in which Salviati describes an experiment to determine the limits of the *horror vacui;* a most interesting discussion of infinitesimals and of infinites; an experiment to determine the velocity of light; a study of the resistance which the air offers to a body moving through it, with a clear statement about the terminal velocity, and the general relation of this to the weight and surface of the body; experiments to determine the specific gravity of air; the isochronism of the pendulum and the relation between its period and its length; and lastly the relation of the pitch of a musical tone to the frequency of the vibration, demonstrated and illustrated by beautiful observations. The range of Galileo's interests and the acuteness of his thought can not be better appreciated than by a study of this book.

On the second day Salviati, after giving Galileo's famous demonstration of the law of the lever, goes on to a more formal study of the relations of the dimensions of beams to their breaking strength.

The third and fourth day are devoted to the study of the motion of bodies. The discussion is the one that is familiar to every one from its use in text-books of mechanics. On the third day the subject considered is linear motion with constant acceleration on inclined planes. On the fourth day it is the path of projectiles. Both these books contain, besides the fundamental propositions which are well known and are still used, a great number of others of less importance, which nevertheless serve to show Galileo's fertility of invention and geometrical skill.

This outline of their contents will show why it was worth while to translate Galileo's Dialogues into English. The book is a recognized classic in physics. The freshness and beauty of the thought and the importance of the matter are unsurpassed. It is a book which should particularly be examined by students of physical science at a stage in their progress at which the appreciation of the great original work of the present day would be impossible. It will bring such students at once into a range of thought which they can understand and will illuminate the arid wastes of the text-books in mechanics with the light of genius.

The translators have succeeded remarkably well in preserving the lightness and grace of the style without sacrificing accuracy of expression. The language used by Galileo is so unsystematic that it must have been often difficult to give the proper equivalents to his words and phrases. One suspects that the correct rendering of a word had sometimes to be determined by geometry. Without being pedantic about it, the translators have tried to use the modern technical equivalents of Galileo's less accurate words, and have succeeded so well that the book can be read easily by any one who has the slightest knowledge of mechanics. The beginner will probably once in a while agree with Simplicio in his rueful

complaint that the author "keeps on assuming that all of Euclid's theorems are as familiar and available as his first axioms, which is far from true." The occasional brief notes of the translators are helpful in the full understanding of the text.

The Dialogues were published in 1638, when Galileo's life was nearly at an end, but it is shown by Professor Favaro in the scholarly introduction which he contributes to this edition, that most of the discoveries described in them were made many years before, while Galileo was at Padua.

The book is printed in a manner worthy of its contents. The diagrams and illustrations are reproductions of the originals. In publishing this translation the authors have done a service to all English-speaking students of the history of physics.

W. F. Magie

Chemistry and Its Borderland. By Alfred W. Stewart, D.Sc., lecturer on organic chemistry in the Queen's University of Belfast, etc. With 11 illustrations and 2 plates. Longmans, Green and Co. 1914. Pp. xii + 314. Price $1.50 net.

The scope of this book is best shown by giving the titles of the fifteen essays of which it consists. They are: The Ramification of Chemistry, The Allies of Chemistry among the Sciences, The Relations between Chemistry and Industry, Immuno-chemistry and some Kindred Problems, Colloids and the Ultramicroscope, The Work of the Spectroscope, Chemistry in Space, The Inert Gases and their Place among the Elements, Radium, Niton, Transmutation, The Nature of the Elements, Chemical Problems of the Present and Future, The Methods of Chemical Research, and The Organization of Chemical Research.

The first three of these essays, as well as the last three, appeal most interestingly to the general non-technical reader. The others, which deal with special developments of chemistry, would hardly be intelligently read by those who have no chemical training, but they do serve well to give the chemist a comprehension of the work that is going on in other branches of his specialty. These particular chapters are, however, somewhat lacking in clarity, especially that on immunochemistry. It is difficult to describe advanced work in any chemical field in easily comprehensible language, and a failure to put the theories of Ehrlich and Metchnikoff successfully into popular language is not to be wondered at. Perhaps it is hardly worth while to try.

The essay on Chemical Problems of the Present and Future presents an interesting discussion of the part to be played by chemistry in energy and food supply. As possible developments along the line of sources of energy are suggested more efficient storage batteries and primary batteries, improved methods of utilizing solar radiations, artificial coal, the use of explosives in gas engines, and the use of radium. In discussing food supply the question of fertilizers is dwelt upon, with comments on the annual loss of $80,000,000 in the nitrogen of sewage carried into the sea. The future use of the seaweeds of the Sargasso Sea is mentioned and a good description is given of the fixation of atmospheric nitrogen in the electric furnace. A second division of the food problem is the discovery of new supplies. These may be materials which have hitherto, as foods, gone to waste, as oleomargarine, or they may be synthetic foods. At present the latter are too expensive to be thought of, but processes for their manufacture on a large scale may some time be discovered. This leads the author to a brief discussion of the possible synthetic production of living tissue.

> We have the means of building up more and more complex protein derivatives, and, sooner or later, we shall probably synthesize substances quite as complex as the natural protoplasmic materials; when this point is reached, unless our knowledge of "vital" reactions has considerably advanced, we shall at best be in the position of a watchmaker who has constructed a watch but has forgotten to make any contrivance for winding it up. At this point, chance might enter into the problem, and the protoplasmic machine we have designed might spontaneously set itself in motion, but more than this we are not entitled to

expect. Experiment is the only possible test, and the date of the crucial trial is still far distant.

This, however, does not prevent the author from indulging in an interesting speculation:

> Suppose that this new protoplasm had properties slightly different from those types which we know; its accidental discovery might involve us in very serious consequences. Assume that it had great powers of assimilation and reproduction, and we might find it rather a dangerous neighbor, so that finally the new discovery might end in the rapid extirpation of the long-sought-for product. Even more serious, however, would be the state of things if the synthetic creature resembled our ordinary bacteria, and was capable of lodging in animals, and there liberating new forms of toxins against which we are not immunized. It is just a possibility, but it would certainly be a most awkward end to an experiment.

The further career of this future Frankenstein may be left to the speculations of H. G. Wells.

The essays on chemical research may well be commended to every one interested in the future of those industries which are in any way connected with the applications of chemistry. While written from an English standpoint, they are none the less applicable in America. In both these countries the future held out to the student of chemistry is by no means attractive and the expectation of adequate remuneration for a life work is less than in many other fields. Yet the future of these industries is bound up with chemical research, and that not merely in the field of the direct applications of chemistry, but even more especially in the field of pure science, and here it is that there is the least hope of adequate remuneration. The outlook is nevertheless not without hope, both in Britain and in America. The foundation of the Carnegie Trust for the Universities of Scotland and the Science Research Scholarships of the Royal Commission for the International Exhibition of 1851 are dwelt on at length, as steps in the right direction, and in an appendix is set forth the Outline of a Scheme for the Improvement of Research Conditions, worthy careful perusal, however much one may disagree with some of the suggestions.

The book is well written and comparatively free from errors, though exception might be taken to the accuracy of occasional statements. We object seriously to the use, unfortunately far too frequent here and elsewhere, of "body" where "substance" or "compound" is meant, and we wonder if the word "researcher," for one engaged in research, has come to stay.

Jas. Lewis Howe

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Nucleic Acids. Their Chemical Properties and Physiological Conduct. By Walter Jones, Ph.D. Longmans, Green & Co. 1914. Pp. viii + 118.

Nucleic acids and their components have held, for more than a century, the interest of the chemist, of the biologist, of the physician, of the pharmacologist, and of the physiologist.

The first acquaintance with the derivatives of nucleic acid was made through the discovery of uric acid by Scheele in the year 1776. The name given to the substance betrays the scanty information of the discoverer concerning the chemical structure of the acid, hence of its exact place in the economy of the organism. The constant occurrence in the urine of appreciable quantities of uric acid may have led one to the conclusion that it belonged to the class of final products of metabolism. What was the mother substance of uric acid? The question could not be answered when information concerning the chemistry of the tissue components, or of food stuffs, was lacking.

Nucleic acids were discovered much later by Altman, a cell biologist. He was in search for an explanation of the staining properties of cell nuclei. The problem, as far as Altman was concerned, was solved by the demonstration of the presence in the cell nuclei of a substance with the properties of an acid. The substance was named nucleic acid. Altman little thought of the possible relationship of the new substance to the uric acid of the urine. On the other hand, the chemists and physicians engaged in researches on uric acid

suspected as little a relationship between the two acids. It required years of labor to bring the two independent lines of inquiry to a common ground and to a mutual understanding.

The inquiry into the chemical structure of uric acid led up to the classical work of Fischer on the "purin" derivatives. This work established the relationship of uric acid to xanthin, hypoxanthin, guanin and adenin—basic substances discovered in the extracts of animal tissues. It then became evident that the uric acid of the urine is a product of animal combustion of purin bases.

On the other hand, the inquiry into the structure of nucleic acids led up to the knowledge that these acids contain in their molecule purin bases. Thus, by some display of imagination, the origin of the purin bases of tissue extracts could be explained by a rupture of the complex structure of the nucleic acid molecule. The genesis and the fate of uric acid became obvious. This triumph of knowledge is unquestionably important for its own sake. However, in this place it may be of service as an illustration of the scope of biological chemistry as compared with that of the structural organic chemistry.

The discovery of the arrangement of atoms in a given molecule is the aim of the structural chemist. The physical and chemical properties of a molecule are determined by the arrangement of the component atoms. The work of the chemist is completed when he is successful in arranging hypothetically all the atoms of the molecule in such a manner that the conduct of the molecule appears a natural sequence of this arrangement.

Not so simple is the task of a biological chemist. A tissue component is not only a chemical, but also a biological unit. It is not only a reacting body but also a structural element of cells and tissues. Furthermore, it reacts not only in its state of integrity, but also in its state of dissociation. The dissociation is most generally a complex process, and is controlled by well regulated mechanisms. In a word, the scope of biological chemistry is not only the chemical structure of substance, but the life cycle of the structure, and the relation of this cycle to that of the other tissue elements.

Hence, the biochemical problems are very complex, and for the present it is difficult to point out any tissue component regarding which our knowledge is complete.

The subject of nucleic acid is one of the most successful chapters in the history of biochemical inquiry. Not that information is complete either in regard to the structure or in regard to the conduct of this group of substances. But the information that is lacking is small as compared with that already acquired. And the information acquired concerns equally the biologist, the chemist and the physician.

To sum up all the recent progress in this field of research is a very difficult undertaking. Professor W. Jones in his monograph on "Nucleic Acids" has acquitted himself of the task in a most masterly manner. The work contains a very systematic and keen analysis of all the numerous publications in this field of biochemical research. And yet, the book reflects the personality of the author and his interests as an investigator. Dr. Jones has contributed considerably to the knowledge of the chemical structure of nucleic acids, but his most important contributions relate to the process of their disintegration in the organism. Naturally the chapters on the "conduct" of the nucleic acids carry most inspiration. Hence, the biologist, the physician, and the physiologist will read the book with special interest. However, also the chemist will find a complete and very comprehensive review of all the work dealing with the chemical structure of nucleic acids.

The first part of the monograph deals with nucleins, nucleoproteins, and with "nucleic acids" in general. The second chapter of this part gives a good account of the chemistry of nucleic acids of animal origin, and the concluding chapter reviews the results of the recent work on the nucleic acids of plant origin.

The second part gives a critical résumé of the very extensive literature dealing with the questions of biological formation of nucleic

acids, and of the process of their disintegration. Reading these chapters, one can not help being impressed by the complexity of the mechanism which controls the catabolism of nucleic acids. There have been described in the animal organism at least a dozen agents (enzymes) taking part in the work of the destruction of nucleic acids. Undoubtedly more will be discovered. Each of the known enzymes is capable of inducing only one reaction, of performing only one phase in the general process.

The reading of these chapters is instructive, not only for the information contained in them, but as an illustration of the means employed by the animal organism in order to bring about a very gradual transformation of the complex tissue components into simpler derivatives. How great must be the number of enzymes residing in animal tissues if more than a dozen are required for the catabolism of only one tissue component!

P. A. Levene

STANDARDIZATION OF COURSES AND GRADES

The following regulations were adopted for the guidance of the faculty at a recent meeting of the president's council of the George Washington University:

To the President's Council: The Committee on Standardizing Grades appointed last June begs leave to submit suggestions upon the following two problems:

1. How can the amount of work required for each unit of credit be approximately equalized in the various courses?

2. What common standard of grading can the various members of the faculty observe so that they will all grade approximately on the same standard?

In submitting principles and standards for the solution of these problems the committee wishes first of all to be understood that it does not wish to dictate, or even to suggest, how any member of the faculty should do his work. It not only has no intention of curtailing the legitimate rights and freedom of any teacher, but it desires especially to emphasize that these rights and freedom are sacred; that they are an indispensable condition for the best type of university work.

But in schools, colleges and universities the personal side is not the only side to teaching. There is present also a social side which grows out of the fact that a school is in some fundamental aspects a social unit. The various members of the faculty are all working to contribute in piecemeal to the same end. They are all contributing to the rounded education of individuals, and to the extent that social relationships are involved in this process to that extent is it necessary to observe similar standards and principles. When this is not done the equilibrium and the efficient working of the whole is disturbed. Students in considerable number will elect those courses in which they can get the largest number of credits or the highest grades, or both, for the least work, and they will shun those courses in which the opposite is true.

But in observing similar standards and principles in those matters that pertain to the school, as a whole, it would seem that no desirable aspect of the personal freedom of the teacher needs to be violated. A common goal only needs to be recognized, the manner of reaching the goal being left to the individual teacher. We have here an example of the type of liberty within law that obtains elsewhere in society.

Equalization of Units

It appears to be true that the amount of work required of students in different courses carrying equal amounts of credit varies greatly. While in some courses little more than attendance upon lectures and the passing of examinations is required, in others from one to three or even four hours of outside preparation for each lesson is required in addition. To minimize this divergence the committee recommends:

(*a*) That all teachers strive to require about two hours of outside preparation for each lesson.

(*b*) That courses which are now so weighted that they can not be completed with this amount of study be readjusted so that they can ordinarily be completed with two hours of preparation for each lesson.

(*c*) That lecture courses in connection with which it is impossible or undesirable to assign any considerable amount of outside work carry one half as many credits as the number of lectures per week.

Distribution of Grades

Considered from the social standpoint, the college, in common with other schools, performs two interrelated, although distinguishable fundamental functions. It (1) educates and it (2) selects.

The educative function is the one commonly recognized and is in outline well understood. It includes the imparting of ideals, knowledge and skill.

The selective function, on the other hand, has been less commonly recognized, but it has always been present and is socially indispensable. The school not only imparts ideals, knowledge and skill, but it also designates those who have acquired these characteristics, and by the assignment of grades it aims to indicate the degree in which they have acquired them.

The giving of grades to students is only one of a number of means that the school uses in discharging the selective function of education, but it is one of the most important. Like other educational functions it must be done carefully, intelligently and uniformly in order to avoid injustice to the student. The desideratum of uniformity requires not only that each teacher always use approximately the same standard with all of his students, but that all teachers use approximately the same standard with all students. When this is not done, the educational equilibrium of the school is disturbed and injustice is done to the earnest and conscientious student. The less serious the students are the more they tend to gravitate toward the teachers that give the higher grades and the injustice that this tends to work upon the conscientious student when it comes to the awarding of honors and the recommending for positions is obvious. The giving of many high grades, furthermore, gives many students a false and exaggerated notion of their ability. The grade of "A" especially should be reserved for very exceptional ability which in the nature of the case is rare.

The principle underlying a uniform standard of grading is found in the distribution of mental ability as revealed by psychological investigations. These investigations have shown, when sufficiently large numbers of people are considered, that ability in general or in any particular line, is distributed in the form of a bell-shaped curve technically known as the probability curve or the normal surface of frequency. Letting the base line represent the degrees of ability from poorest to best and the vertical lines the numbers of persons possessing each degree of ability, it is clear that there is but a small number of students with excellent ability, a larger number with good ability, a relatively large number with medium or average ability, a smaller number with sub-medium but passing ability, and a small number with distinctly unsatisfactory ability.

There are, of course, no sharp dividing lines between these different groups, and any such lines that are drawn are arbitrary. But when the base line is divided into five equal steps, representing therefore five approximately equal steps of ability, the percentages of students that fall into each group are approximately as follows:

		Per Cent.
Excellent	(A)	4
Good	(B)	24
Medium	(C)	44
Sub-medium	(D)	24
Failure	(E)	4
Total		100

These percentages mean in the present connection that a teacher's grades should in the long run be distributed approximately in the amounts indicated by these percentages. The grade of "A," or excellent, should be assigned to about 4 per cent. of the students; "B," or good, to about 24 per cent.; "C," or medium, to about 44 per cent.; "D," or sub-medium, to about 24 per cent.; and "E," or failure, to about 4 per cent. It is quite likely that the percentage of failures in the lower classes may properly be somewhat higher than that in the upper, with corresponding changes in the other percentages, and failures may perhaps also properly be more frequent in professional schools than in liberal culture schools. Because of its immediate social responsibility, it is the duty of the professional school to apply the principle of selection rigidly.

It should, however, not be inferred that the grades assigned in any particular class, especially in a small class, must approximate closely to the distribution above given. The expression, "in the long run," should be emphasized. The principle can not be applied mechanically, but it devolves upon each teacher to school himself to recognize excellent ability, good ability, and so on.

W. C. Ruediger,
Geo. N. Henning,
Wm. A. Wilbur,
Committee

SPECIAL ARTICLES

CORRELATION BETWEEN THE TERTIARY OF THE GREAT BASIN AND THAT OF THE MARGINAL MARINE PROVINCE IN CALIFORNIA

In December, 1913, a party of students from the University of California working

under the leadership of Dr. Bruce Clark, instructor in paleontology, obtained an interesting collection of remains of land mammals in Tertiary deposits north of Coalinga, on the west side of the Great Valley of California. As the Tertiary section in the Coalinga region is a part of the marginal marine series of Californian formations, and the mammalian remains obtained in these beds represent a land fauna best known in the epicontinental deposits ranging from the Great Basin east to the Great Plains region, this occurrence offers an unusual opportunity for correlation between the marginal marine province and the mammal-bearing deposits of the interior of the continent.

Evidence bearing on the problem of correlation between the Great Basin and the Pacific Coast province is particularly welcome at this time, since there has been reason to believe that the geologic scales used in the two regions have not coincided in the limits of the periods.

The mammalian remains obtained in the North Coalinga region were found at not less than four horizons ranging from beds generally considered to be Lower Miocene or Upper Oligocene, to a horizon of Pleistocene or Pliocene stage. The occurrence of the faunal zones in the sequence of deposits in the North Coalinga region is shown in the table.

The lowest horizon is characterized by abundance of horse teeth representing the genus *Merychippus*, and may be known as the Merychippus zone. At the second horizon from the base comparatively few remains are known. The presence of teeth of *Neohipparion* suggests the tentative designation of this portion of the section as the Neohipparion zone. The third of the principal horizons is characterized by the presence of a new species of horse designated as *Protohippus coalingensis* and may be known as the Protohippus coalingensis zone. The latest fauna is distinguished by the presence of a large specialized horse, probably representing the genus *Equus*, and by remains of a form near *Cervus*. This may be known as the Equus-Cervus fauna.

Occurrence of Mammal Zones in Tertiary Beds of the North Coalinga Region of California

Time Divisions		Local Formations	Mammal Zones
Pleistocene		Terrace deposits	? Equus-Cervus fauna in part
Pliocene		Tulare	
		Etchegoin	Protohippus coalingensis
		Jacalitos	Neohipparion
Miocene	Upper	"Santa Margarita"	
	Middle	"Temblor"	Merychippus
	Lower		

The fauna of the Merychippus zone occurring in the "Temblor" beds commonly recognized as Lower Miocene, includes the following types.

Merychippus, n. sp.
Tetrabelodon ?, sp.
Procamelus ?, sp.
Prosthennops ?, sp.
Desmostylus, near *hesperus* Marsh.
Isurus, sp.

The horses of the Merychippus zone correspond very closely in most respects to *Merychippus isonesus* of the Mascall Middle Miocene of the eastern Oregon region. The stage of evolution of the teeth of this form is not reached by any species of the Lower Miocene in America. The proboscidean, *Tetrabelodon?*, has no certainly known relatives in America earlier than the Middle Miocene of our accepted scale. The camel resembles a late Miocene type. It seems impossible to refer this fauna to a stage older than that of the Mascall Miocene of the mammalian sequence of the Great Basin province.

From the occurrence of the Merychippus

fauna in the "Temblor" beds of the North Coalinga region, it seems clear that these marine beds, commonly referred to Lower Miocene or late Oligocene, are not older than mammal-bearing beds of the interior of the continent referred to Middle Miocene.

The "Temblor" beds of southern California represent a phase of the Monterey series of California, which is one of the best known and most widely spread of the divisions of the Tertiary. There seems good reason to believe that the Monterey series of California is approximately to be correlated with the Mascall Middle Miocene of the Great Basin.

A broad consideration of the lack of adjustment between the time scale of the Pacific Coast province and that of the Great Basin suggests that correlations of marine faunas of the Pacific Coast region, particularly those based on the percentage method, have tended to locate the time divisions relatively too far from the present or Recent. In late years, the refinement of specific characterization has proceeded very rapidly. Splitting the species has resulted in giving us a larger number of forms each of which has a relatively restricted geographic and geologic range. The percentage method, as proposed by Lyell, when used with modern species naturally results in pushing time divisions farther apart.

The lack of adjustment in the time scale also suggests the desirability of testing the relation of Middle Miocene mammal-bearing beds of North America to the formations of Lower Miocene age in the European scale.

The fauna of the second mammal zone of the Coalinga region comes from beds referred for the present to the Jacalitos formation. It includes a form referred to *Protohippus* by Arnold and Anderson, and a *Neohipparion* species of somewhat advanced stage. The *Neohipparion* material from this zone is insufficient for thoroughly satisfactory comparison. It seems in part to be related to a *Neohipparion* from the Rattlesnake Pliocene of the John Day region of eastern Oregon. This species does not appear to be very closely related to the well-known *Hipparion* species in the Ricardo fauna from the Mohave Desert.

The fauna of the third or Protohippus coalingensis zone of the Etchegoin formation in the Coalinga region has as its most characteristic form a new species, *Protohippus coalingensis*,[1] which differs from all the described species found west of the Wasatch Range. It is most nearly related to a species represented in the Ricardo fauna of the Mohave Desert. It does not, however, seem to be identical with the Ricardo form. The stage of this fauna, in very general terms, seems to be Pliocene. Both the Etchegoin of this zone and the Jacalitos below it were referred by Arnold and Anderson[2] to the Upper Miocene.

The fourth fauna of the North Coalinga region includes a number of species of relatively modern aspect. These include forms referable to *Equus* and to *Cervus* or *Odocoileus*. This assemblage may be known for the present as the Equus-Cervus fauna. Its stratigraphic position is not entirely clear. The fauna is in part much like that of the Pleistocene.

JOHN C. MERRIAM

THE CRENATION AND FLAGELLATION OF HUMAN ERYTHROCYTES

I. *Crenation*

THE method of preparing the blood on which the following observations on crenation were made is very simple. A drop of blood obtained by pricking the finger is immediately sucked up into a pipette which contains one to two cubic centimeters of sterile Ringer's solution or 0.85 per cent. sterile sodium chloride or human blood serum. The suspension is then mixed on a sterile glass slide until a homogeneous suspension is obtained. A drop of the suspension is then transferred by means of a pipette to an absolutely clean large coverslip and the drop allowed to spread out into a thin

[1] *Protohippus coalingensis*, n. sp. Type specimen, No. 21,341, Univ. Cal. Col. Vert. Palæ. Distinguished by large size, unusual narrowness of cheek-teeth in transverse diameter, small protocone and narrow, simple fossettes.

[2] Arnold, R., and Anderson, R., U. S. Geol. Surv. Bull. No. 398, p. 78, 1910.

film. The preparation is then mounted in a glass moist chamber, open to the air at one end, and examined at ordinary room temperature. A drop of untreated human blood mounted in a moist chamber serves equally well, if the corpuscles be more or less separated, by spreading the blood into a thin film on the cover-slip.

The preparations were studied at room temperature by means of both natural and artificial light. A frosted Mazda light globe of sixty watts was used as the source of illumination, the light being passed through a glass container containing sufficient copper chloride to impart a weak blue color to the solution. The following observations were made with an ordinary Leitz 1:12 oil immersion lens and a No. 4 ocular. Certain finer details of structure were better revealed by a No. 12 compensating ocular.

The microdissection technique used is the same as that employed by Kite[1] and involves the use of the Barbour pipette holder, the Barbour moist chamber, and exceedingly fine (1–2 microns) hard Jena glass needles and pipettes.

When blood is prepared as above described certain of the cells are seen to have undergone more or less pronounced crenation as soon as they can be examined. If now a very fine needle point be brought up under a crenated erythrocyte, then carefully elevated so as to just touch the cell, and then immediately lowered, the corpuscle instantly regains an optically normal appearance and retains it for hours. Crenated cells thus brought back to the normal have never been seen to undergo subsequent crenation if left undisturbed. (It should be noted that in bringing the fine point of the dissecting needle into contact with the cell extreme care must be taken; otherwise, although the cell immediately rounds up and swells, yet within 20 to 30 seconds the hæmoglobin dissolves out and only a so-called "shadow corpuscle" remains.)

If a fine needle be raised into a drop containing normal red blood cells no crenation occurs when the needle pierces the meniscus of the drop. If now the needle point be brought up alongside the cell (not touching the cell but in the same focal plane) the corpuscle immediately crenates. The amount of crenation seems to be dependent somewhat on the proximity of the needle to the cell. As long as the needle remains in place the crenation persists, but as soon as the needle is lowered out of the focal plane of the cell the corpuscle instantly goes back to the normal. This experiment of crenating and uncrenating a cell can be indulged in indefinitely, with always the same results.

Various methods were employed. If, for instance, a fine microdissection needle be brought up alongside a completely crenated cell, and if the needle point be then carefully moved against the cell, pushing in a small arc of the cell substance before it, immediately on lowering the needle away from the cell, the corpuscle rounds up and swells. In all the above-quoted and subsequent experiments cells brought back from the crenated stage remained intact and optically normal. In fact, such cells can not be distinguished from absolutely normal red-blood cells.

Even more striking results on a somewhat larger scale are obtained when, instead of a needle, a very fine pipette is employed. The best results are obtained with a glass pipette whose lumen is not more than one micron in diameter. If such a pipette be raised into a field of crenated erythrocytes the instant the pipette pierces the meniscus of the drop all of the crenated and otherwise distorted cells in the field immediately round up and retain their perfectly normal, regular outline and appearance so long as the pipette is allowed to remain in the drop. If now the pipette be lowered out of the drop, all the cells immediately go back to their irregular, crenated shape. The cells that were originally of a pointed oval shape, etc., for instance, return to their oval form, and the variously crenated cells return to their original stage of crenation.

If, into a drop containing perfectly normal red-blood cells, a very fine pipette is raised and the experimenter exerts a very slight suction

[1] A detailed description of the method will be published shortly.

on the pipette, all the cells within a more or less definite zone about the pipette instantly crenate. If now the experimenter blows into the pipette very slightly (the pipette, of course, still being in the drop) the cells immediately round up and remain perfectly normal. This alternate crenating and uncrenating the cells can be indulged in repeatedly.

Examination of red-blood cells kept for hours in a moist chamber gives evidence that probably there are a number of more or less definite types and stages of crenation. In preparations of crenated erythrocytes a varying number (dependent somewhat upon the age of the preparation) are seen to undergo an internal change (as noted by Kite) which is characterized by the formation of refractile granules and rods, of somewhat definite size, in the cell substance. The exact relation of this phase to crenation has not yet been determined. The deposition of these rods and granules is very possibly a coagulation phenomenon. Cells that have undergone such a change are apparently more stable and less easily brought back to the normal than crenated but optically homogeneous corpuscles. Such cells can be sucked up into a pipette and expelled into the same or different drop without undergoing any apparent alteration in shape or size. Such a cell can, however, be brought back to the normal by raising a needle against the cell body and immediately lowering it. The granules and rods instantly disappear and the cell immediately assumes an apparently permanent normal outline and appearance.

All of the above experiments can be performed equally well whether the blood cells be mounted in an isotonic, slightly hypotonic or slightly hypertonic solution. Certain of the experiments, especially, would seem to indicate that the phenomenon is apparently outside the sphere of any possible osmotic process, dependent upon an alteration in a hypothetical semipermeable membrane around the red-blood corpuscle. Rather the experiments would lead one to suspect that the shape a red-blood cell assumes is an expression of surface tension forces. The experiments also serve to emphasize the extreme irritability of protoplasm.

II. *Flagellation*

In an article[2] to be published shortly in the *Journal of Infectious Diseases,* Kite records a series of dark-field observations on the structural modifications undergone by the blood cells of various vertebrates when mounted in liquid plasma containing Ringer's fluid and hirudin and examined in sealed preparations. He records dark field observations of various types of both motile and non-motile processes which appear on the blood cells of vertebrates.

After studying certain of these structural changes in sealed preparations by means of the dark field and special condensers it seemed of interest to more carefully study red-blood cells mounted in a Barbour moist chamber freely open to the air, and to determine whether these changes could be seen by ordinary transmitted light and without the aid of special condensers. For this purpose the following experiments were undertaken. It should be recorded here that, although one type of process mentioned below is apparently coarser and of a somewhat different nature than any of the processes figured by Kite, yet there is no reason to suppose that this type of process is anything more than possibly another phase in the transformations described by him. As can be determined by reference to Kite's paper, priority of certain of the following observations made under somewhat different conditions belong to him. Control observations with hirudinized preparations have been made with the same results. The method of preparing the microscopic mounts is the same as described above under crenation.

Immediately upon making the preparation a large proportion of the red-blood cells are seen to possess very short non-motile spinous processes which line the entire periphery of the cell. Within forty to fifty minutes after the preparation is made the erythrocytes are seen to possess long processes, some of which exhibit a rapid whip-like motion, others a slow undu-

2 "Some Structural Modifications of the Blood Cells of Vertebrates," G. L. Kite. Read before the Society for Experimental Biology and Medicine, April 15, 1914.

latory movement, while still others are absolutely motionless. These processes, which can be seen to be thrown out from the cell and possess unquestioned continuity with the cell, apparently originate from small blunt projections which appear on the surface of the cell. These processes appear alike on crenated and uncrenated cells, are comparatively easily seen, and vary in length from two to three microns to as long as 30 microns. Under certain conditions, the details of which have not been worked out, they are capable of extremely rapid retraction. Frequently oval erythrocytes with the two ends drawn out into a long fine whipping process which may have a length of five to six times the diameter of the cell are found. Cells with these beating processes are rapidly whipped across the field. These long fine processes, when they first appear on the red cells, are of a clear, non-granular nature. After whipping for twenty to thirty minutes they have been seen to take on a granular, beaded appearance. The beaded processes continue to beat. If watched, certain of these processes can be seen to break off from the cell, and even after being detached, continue to whip across the field. If these detached processes are further observed they can be seen to eventually break down, the granules floating free in the preparation and exhibiting marked Brownian movements. These granules apparently hold up, and at the end of five or six hours are found in large numbers.

By means of the microdissection technique devised by Kite the fine beating processes on the red blood cells have been dissected off. When a process is dissected off the cell, the broken-off process may remain sticking to the point of the needle. The free end continues to whip for as long as forty minutes after being detached from the cell. If a process be dissected off near the cell the small portion remaining attached to the cell continues to whip.

If a motionless process on an erythrocyte is touched at any point along its extent by a very fine needle the process immediately begins to whip. For instance, an erythrocyte of perfectly regular outline with a long (20–30 micron) process at each pole of the cell was watched for forty-five minutes. During this time the cell did not change in outline, and the cell and its processes remained absolutely motionless. At the end of this time one of the processes was touched near its base. The process immediately commenced to whip, and the motionless process at the other pole of the cell took on a very slow undulatory movement. When this latter undulating process was touched by the needle, it, too, immediately commenced to whip. The two actively whipping processes soon carried the cell out of the field, and the cell was followed in its progress through a number of fields. At the end of thirty minutes the processes were still whipping the cell through the preparation. The long processes are exceedingly flexible and seem to beat in an arhythmic manner. They frequently are seen to whip around the cell to which they are attached, and become glued to the surface of the cell. After several minutes they can be seen to beat free from the cell and continue their active whipping motion. The apparent viscidity of the processes is evidenced by the fact that two or more beating processes of the same or neighboring cell frequently become entangled and stick together. They may become freed naturally, or they can be pulled apart by means of the dissecting needle. At times the middle portion of a long process becomes stuck to the cell while the free terminal portion continues to whip.

If a dissecting needle be brought up along side the middle portion of one of these long beating processes, and this portion then be carefully pushed so as to form an arc, the distal portion of the process continues to beat in a line with the motionless proximal portion. If too much tension is placed on the process it is torn loose. The various types of motile and non-motile processes on the red-blood cells can be found in moist chamber preparations of blood mounted in 0.85 per cent. sodium chloride for many hours after the preparation is made (at least twenty-four hours).

Wade W. Oliver

Marine Biological Laboratory,
Woods Hole

SCIENCE

FRIDAY, NOVEMBER 6, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE GERMPLASM AS A STEREOCHEMIC SYSTEM[1]

THE discovery in 1883 by Dr. S. Weir Mitchell and myself that the toxic principles of the venoms of serpents are albuminous marked an era in the chemistry, physiology and pathology of proteins, and among other things laid the foundation of our knowledge of bacterial and other toxalbumins. Since that time our information of the properties of albuminous substances, then extremely meager and somewhat chaotic, has greatly advanced, and many investigations have been made to determine the precise nature of these poisons, with the effect of more or less modifying the statements we then set forth. The astonishing fact that these terribly lethal substances were found by the tests of the day to be proteins, and that apart from their toxic properties they were indistinguishable from corresponding bodies that are ingested as food or derived therefrom by the processes of digestion, or found as normal constituents of the living tissues generally, naturally led me to much speculation and ultimately to the pursuit of the very elaborate series of researches that I have been carrying on during the past decade under the auspices of the Carnegie Institution of Washington, reports of two of which have appeared as Publications Nos. 116 and 173.

It would be futile for me to attempt within the necessarily restricted time that can reasonably be allotted to the reading of a communication to present in a satisfactory form even the briefest summary of the very voluminous results and conclusions that are embodied in these works, or even an outline of

[1] Read by title at the meeting of the American Philosophical Society, April 25, 1914, and in full before the Society of Normal and Pathological Physiology of the University of Pennsylvania, April 28, 1914.

their bearings upon a vast number of problems of normal and abnormal biology, so that perforce my remarks shall be limited to a fragment—a fragment which bears upon one of the most baffling yet all-absorbing problems of life, why "like begets like."

A. The Specificity of Stereoisomerides in Relation to Genera, Species, etc.

These researches have as their essential basis the conception that *in different organisms corresponding complex organic substances that constitute the supreme structural components of protoplasm and the major synthetic products of protoplasmic activity are not in any case absolutely identical in chemical constitution, and that each such substance may exist in countless modifications, each modification being characteristic of the form of protoplasm, the organ, the individual, the sex, the species and the genus.* This conception was supported not only by the extraordinary differences noted between the albuminous substances of venom and those of other parts of the serpent, but also by the results of the investigations of Hanriot, who described marked differences in the properties of the lipases of the pancreatic juice and the blood; of Hoppe-Seyler and others who stated that the pepsins of cold- and warm-blooded animals are not identical; of Wróblewsky and others who recorded differences in the pepsins of mammals; of Kossell and his students who found that the protamins obtained from the spermatozoa of different species of fish are not identical; and of various observers who have noted that the erythrocytes of one species when injected into the blood of another are in the nature of foreign bodies and rapidly destroyed. During subsequent years, and especially very recently, data have been rapidly accumulating along many and diverse lines of investigation which collectively indicate that every individual is a chemical entity that differs in characteristic particulars from every other. To any one familiar with the advances of biochemistry and with the trend of scientific progress towards the explanation of vital phenomena on a physico-chemical basis, it will be obvious that if the conception of the non-uniform constitution of corresponding proteins and other corresponding complex organic substances in different organisms and parts of organisms were found to be justified by the results of laboratory investigation a bewildering field of speculation, reasoning and investigation would be laid open—a field so extensive as to include every domain of biological science, and seemingly to render possible, and even probable, a logical explanation of the mechanisms underlying the differentiation of individuals, sex, varieties, species and genera; of the causes of fluctuations and mutations; of the phenomena of Mendelism and heredity in general; of the processes of fecundation and sex-determination; of the tolerance of certain organisms to organic poisons that may be extremely virulent to other forms of life; of tumor formation, reversions, malformations and monsters; of anaphylaxis, certain toxemias, immunities, etc.; and of a vast number of other phenomena of normal and abnormal life which as yet are partially or wholly clothed in mystery.

Some years previous to the discovery of the nature of the lethal constituents of venoms, Pasteur found that there exist three kinds of tartaric acid which, because of different effects on the ray of polarized light, are distinguished as the dextro-, lævo- and racemic-tartaric acids, the dextro form rotating the ray to the right, the lævo form to the left, and the racemic form not at all. When these acids were subjected in separate solutions to the actions of *Penicillium glaucum* fermentation proceeded in the dextro form, but not in the lævo form, while in the solution of the racemic acid, which is a mixture of the dextro and lævo acids, the dextro form disappeared, leaving the lævo moiety unaffected. All three acids have the same chemical composition and chemical properties, but differ strikingly in their effects on polarized light and in nutritive properties. Identical or corresponding peculiarities have since been recorded in relation to a large number of substances. Thus, of the twelve known forms of hexoses, or glucoses, only the dextro forms are fermentable,

that is, capable of being used by certain low organisms as food, but not all are thus available, and, moreover, those which are show marked differences in the degree of fermentability. In the case of other substances *Penicillium* may consume the lævo form, but not the dextro form. Other organisms show similar selectivities, using either dextro or lævo form, or both, but in the latter case in unequal degree. Even more striking instances have been recorded in the actions of poisons, as, for instance, dextro-nicotine is only half as toxic as the lævo form; dextro-adrenalin has only one twelfth the power of the lævo form; racemic-cocaine has a quicker and more intense but less lasting action than the lævo form; the asparagines, hyoscines, hyoscyamines and other substances have been found to exhibit marked differences in accordance with variations in their optical properties. With other bodies belonging to this category it may be found that one form is sweet while another is tasteless; another may be odorous, but its enantiomorphous form without odor.

To the foregoing there may be added examples of other substances that exist in several forms, but which physico-chemically belong to a different class. Thus, nitroglycerine may exist in forms that are so different that under given conditions of temperature and percussion one is explosive and the other non-explosive. Differences in substances which are found in allotropic forms may be as marked as in any of the preceding illustrations, as, for instance, in the case of phosphorus, which is familiar as the yellow, white, black and red varieties, all of which with the exception of red phosphorus are exceedingly poisonous, while the latter is inert. The ortho, meta and para forms of a given substance may exhibit more or less marked physiological and toxicological variations, and so on.

The explanation of the remarkable differences shown by these substances, which differences are paralleled by those manifested by the lethal and innocuous proteins of the serpent, the pepsins, the protamins and the red blood corpuscles is to be found in the results of two independent but intimately related lines of physico-chemical research: (1) The investigations of Van't Hoff and LeBel and subsequent observers which have laid the foundation of a new, and to the biologist and physician an extraordinarily important, development of chemistry known as stereochemistry—a department that treats of the arrangements of the atoms, groups and masses of molecules, or in other words of intramolecular arrangement or configuration of molecular components in the three dimensions of space. (2) The investigations of Willard Gibbs and others which have given us the "phase rule," which defines the phases or forms in which a given substance or combination of substances may exist owing to differences in intramolecular and extramolecular arrangements and concentration of their components in relation to temperature and pressure.

According to stereochemistry a given substance may exist in multiple forms dependent upon differences in the configuration of the molecule, all of which forms have in common the fundamental chemical characteristics of a given prototype, yet each may have certain properties which positively distinguish it from the others. Theoretically, such substances as serum albumin, serum globulin, hemoglobin, starch, glycogen and chlorophyl may be produced by nature in countless modified forms, owing to differences in intramolecular arrangements. Miescher has estimated that the serum globulin molecule may exist in a thousand million forms. Substances that exist in such multiple forms of a prototype are distinguished as stereoisomers. The remarkable fact has been noted by Fischer and others that stereoisomers may exhibit as great or even greater differences in their properties than those manifested by even closely related isomers, which latter in comparison with stereoisomers are distantly if at all chemically related. As already instanced, so slight a change in molecular configuration as gives rise to dextro and lævo forms may be sufficient to cause definite and characteristic and even profound differences in physical, nutritive and physiological properties.

In accordance with the "phase rule" a sub-

stance or a combination of substances may exist in the form of heterogeneous or homogeneous systems, a heterogeneous system consisting of a number of homogeneous systems, each of which latter is a manifestation of an individual phase and distinguishable from the others by physical, mechanical, chemical or physiological properties. The number of phases of a heterogeneous system increases with the number of component systems, and the number of the latter is in direct relationship to the number of independent variable constituents. Therefore, by means of variations of either or both intramolecular or extramolecular arrangement the number of forms of a substance or combination of substances may range from few to infinite.

Our means of differentiating stereoisomers are, on the whole, limited, and for the most part crude, and while it has been found that differences so marked as those referred to may be detected by the ordinary procedures, it seems obvious that the inherent limitations of such methods render them inadequate where a large number of stereoisomerides or related bodies which may exhibit only obscure modifications are to be definitely differentiated, so that other and more sensitive methods must be sought, or at least special methods that are adapted to exceptional conditions. The results of much preliminary investigation in this direction led in one research to the adoption of the crystallographic method, especially the use of the polarizing microscope, which in its very modern developments of analysis has demonstrated that substances which have different molecular structures exhibit corresponding differences in crystalline form and polariscopic properties; and, moreover, that the "optical reactions" may be found to be as distinctive and as exact analytically as the reactions obtained by the conventional methods of the chemist. Furthermore, the necessities of the hypothesis demanded the selection of a substance for study of a character which upon theoretical grounds might be expected to exist in nature widely distributed and readily procurable, and, as a consequence, hemoglobin was selected.

In the investigation of the hemoglobins I had as a coworker Professor Amos Peaslee Brown. Hemoglobins were examined that were obtained from over 100 animals, representing a large variety of species, genera and families. From the data recorded certain facts are especially conspicuous, among which may be mentioned the following:

1. The constant recurrence of certain angles, plane and dihedral, in the hemoglobins of various species, even when the species are widely separated and the crystals belong to various crystal systems. This feature indicates a common structure of the hemoglobin molecules, whatever their source.

2. The constant recurrence of certain types of twinning in the hemoglobins, and the prevalence of mimosie. This has the same significance as the foregoing.

3. The constancy of generic characters in the crystals. The crystals of the various species of any genus belong to a crystallographic group. When their characters are tabulated they at once recall crystallographic groups of inorganic compounds. The crystals of the genus *Felis* constitute an isomorphous group which is as strictly isomorphous as the groups of rhombohedral and orthorhombic carbonates among minerals, or the more complex molecules of the members of the group of monosymmetric double sulphates.

4. The crystallographic specificity in relation to species. The crystals of each species of a genus, when they are favorably developed for examination in the polarizing microscope, can usually be distinguished from each other by definite angles and other properties, while preserving the isomorphous character belonging to the genus. Where, on account of difficulty of measurement, the differences can not be given a quantitative value variations in habit and mode of growth of the crystals often show specific differences.

5. The occurrence of several types of oxyhemoglobin in members of certain genera. In some species the oxyhemoglobin is dimorphous and in others trimorphous. Where several types of crystals occur in this way in the species of a genus the crystals of each type

may be arranged in an isomorphous series. In other words, certain genera as regards the hemoglobins are isodimorphous and others isotrimorphous.

6. When orders, families, genera or species are well separated the hemoglobins are correspondingly markedly differentiated. For instance, so different are the hemoglobins of *Aves, Marsupialia, Ungulata* and *Rodentia* that there would be no more likelihood of confounding the hemoglobins than there would be of mistaking the animals themselves. Even where there is much less zoological separation, as in the case of the genera of a given family, but where there is well-marked zoological distinction, the hemoglobins are so different as to permit readily of positive diagnosis. When, however, the relationships are close the hemoglobins are correspondingly close, so that in instances of an alliance such as in *Canis, Vulpes* and *Urocyon,* which genera years ago were included in one genus (and doubtless correctly) the hemoglobins are very much alike, and in these cases they may exhibit closer resemblances than may be found in general in specimens obtained from well-separated species of a genus.

So distinctive zoologically are these modified forms of hemoglobins that we had no difficulty in recognizing that the common white rat is the albino of *Mus norvegicus* (*Mus norvegicus albus* Hatai) and not of *Mus rattus,* as almost universally stated, and that Ursidæ are related to Phocidæ (as suggested by Mivart 30 years ago), but not to Canidæ, as stated in modern works on zoology. Moreover, we were quick to detect errors in labeling, as, for instance, when a specimen marked as coming from a species of *Papio* was found to belong to one of the Felidæ. Generic forms of hemoglobin when obtained from well-separated genera are, in fact, so different in their molecular structures that when any two are together in solution they do not fuse to form a single kind of hemoglobin or a homogeneous solution, but continue as discrete disunited particles, so that when crystallization occurs each crystallizes independently of the other and without modification other than that which is dependent upon such incidental conditions as are to be taken into account ordinarily during crystallization. Thus, the hemoglobin of the dog crystallizes in rhombic prisms which have a diamond-shaped cross-section; that of the guinea-pig in tetrahedra; that of the squirrel in hexagonal plates; and that of the rat in elongated six-sided plates. When any two of these hemoglobins are together in solution and crystallization occurs, each appears in its own form. Such phenomena indicate that the structures of the hemoglobin molecules are quite different; in fact, more differentiated than the molecules of members of an isomorphous group of simple carbonates, such as the carbonates of calcium and magnesium which when in separate solutions crystallize in rhombohedrons whose corresponding angles differ 2° 15′, but which when in molecular union, as in the mineral dolomite, crystallize as a single substance which has an intermediate angle.

Upon the basis of our data it is not going too far to assume that it has been satisfactorily demonstrated theoretically, inferentially and experimentally that at least this one substance (hemoglobin) may exist in an inconceivable number of stereoisomeric forms,[2] each form being peculiar to at least genus and species and so decidedly differentiated as to render the "hemoglobin crystal test" more sensitive in the recognition of animals and animal relationships than the "zooprecipitin test."

Subsequent to the research referred to investigations have been pursued in the study of hemoglobins from various additional sources, especially from representatives of *Primates,* with the result in the latter case of finding indubitable evidence of an ancestral alliance of man and the man-like apes.

More or less elaborate studies by crystallographic and other methods have also been made with other albuminous substances and with starches, glycogens, phytocholesterins, chlo-

[2] Even if we assume that the different forms are not, strictly speaking, stereoisomers it must be admitted that hemoglobin exists in forms that are specifically modified in relation to genera and species.

rophyls and other complex synthetic products of animal and plant life, especially with starches, of which over 300 specimens were examined that were obtained from different plant sources, including representatives of a considerable number of families, genera, species, varieties and hybrids. In all of these investigations the results are not only in full accord with those of the hemoglobin researches but also in some instances of broader significance because by better methods of differentiation in some cases it was found possible to recognize not only peculiarities as regards genus or species, but also varieties and hybrids, and even to trace in hybrids with marked definiteness the transmission of parental characteristics.

Summing up the results of these independent but interwoven researches, we find that the modified forms of each of these substances lend themselves to a very definite system of classification, and to one that is in general accord with that of the botanist and zoologist, that is, each genus is characterized by a distinctive type of hemoglobin, albumin, starch, etc., as the case may be, which may be designated the generic-type; every species of the genus will have a modification of this type, which is a species-type, or generic primary sub-type; and every variety of a species will have a modification of the species-type, that is a variety-type, or generic secondary sub-type, or species sub-type. In fact, it seems clear that with revisions of present classifications that are certain to come there will be found definite family types; and, moreover, that with improved methods of differentiation there will be discovered positively distinctive sex- and individual-types. This last statement already has support in the results of collateral lines of research which bear upon the specificities of enzymes, anaphylaxis, precipitin reactions, immune sera, etc.

From the foregoing data it seems obvious that *the complex organic substances which may be assumed to constitute the essential fundamental constituents of protoplasm and the immediate complex synthetic products of protoplasmic activity may exist in exceedingly numerous or even countless stereoisomeric forms, each form being peculiarly and specifically modified in relation to genus, species, variety, race, sex, individual or even part of an individual.*

B. Protoplasm a Complex Stereoisomeric System

The next logical step in our investigation is manifestly the study of the bearings of these stereoisomers, as such and in their variable combinations and associations, upon the structure, processes and products of protoplasm. Protoplasm according to the modern developments of biochemistry is to be regarded as being in the nature of an extremely complex, labile aggregate of proteins, fats, carbohydrates and other substances that are peculiarly associated to constitute a physico-chemical mechanism. The possible number of "phases" in which such a system can exist varies with the forms of the stereoisomerides and in general with the number and independent variability of the components. In such a mechanism we conceive that the number of variables is inconceivably great. From analogy we believe that such mechanisms are so extremely sensitive that the properties and processes may be modified by even so slight a change as the substitution of one form of stereoisomeride for another of the same prototype. Were it practicable to examine all of the most complex of the organic structural components of protoplasm, it doubtless would be found that every one exists in a form that is peculiar to the individual and his position in classification. Moreover, we must conceive that the components of protoplasm are as specific in relation to the form of protoplasm as are the peculiar forms of stereoisomers, so that different forms of protoplasm are characterized physico-chemically (1) by the peculiarities of the stereoisomerides, and (2) by the peculiarities of the kinds, combinations, associations and arrangements of the components in the three dimensions of space.

In accordance with the foregoing the human organism may be regarded as being a highly organized composite of heterogeneous physico-

chemical systems that are composed of a vast number of parts, each such part representing a particular "phase" of the system and being physically, mechanically, chemically and functionally an individual interacting unit of the aggregate. Hence, it follows that the sum or totality of these peculiarly modified stereoisomers *per se*, and of their arrangements with the associated components, constitutes a "stereochemic system" that is peculiar to the cell; that the sum of the cell-systems is peculiar to the tissue; that the sum of the tissue-systems is peculiar to the organ; and that the sum of the organ-systems is peculiar to the individual.

While the living organism had been for years recognized as being in the nature of an exceedingly complex physico-chemical aggregate of interacting independent and interdependent parts that constitute a single working unit, it has been in only recent years that the mechanisms that bring about cooperative activities of the various parts has been made clear. The governing influences of the nervous system were found inadequate even in the highest organisms, not to speak of forms of life in which such actions occur, but in which there is apparently a total absence of nervous matter. As an associate of the nervous system, and doubtless far antedating it in organic evolution, is a correlative mechanism of a chemical character that is of the greatest importance, and doubtless equally so throughout the whole range of living organisms from the lowest to the highest. Every living cell, whether it be in the form of a unicellular organism or a component of a multicellular organism, is undoubtedly in the nature of a heterogeneous stereochemic system, each of the component parts of the system forming substances which may affect directly or indirectly the activities of the processes of the other parts; likewise every cell of a multicellular organism is not only in itself a heterogeneous system, but a part of a number of associated heterogeneous systems and which by virtue of certain of its products, with or without the agency of the blood-vascular or lymph-vascular systems, may exercise influences upon other structures, which structures may have or seemingly not have either structural or physiological relationship. Thus we find that a secretin formed in the pyloric glands of the gastric mucosa may excite the glands of the cardia; that growth is determined by some product or products of the pituitary body that are carried to the various structures; that the liver, pancreas and intestinal glands are excited to secretory activity by a peculiar substance formed in the duodenal and jejunal mucosæ; that carbohydrate metabolism in the liver and muscle is influenced to a profound degree by hormones that are formed in the pancreas; that lactation is determined essentially by substances derived from the corpus luteum, placenta and involuting womb; that the periods of ovulation and menstruation are inhibited by secretins of the corpus luteum; that vitally important states of activity of the generative organs are directly associated with functions of the adrenal glands; and that normal development, especially of secondary sexual characters, is intimately related to the ovaries and testicles. To these extraordinary correlations might be added many others. Some of the bodily structures are in this way so definitely associated in their activities as to constitute cooperating or interacting systems, so that the tissue products are complementary, supplementary, synergistic or antagonistic in their influences upon given structures. Such correlations must be, for perfectly obvious reasons, one of the most primitive forms of interprotoplasmic correlation, and we are justified, upon the basis of our present knowledge, in the conclusion that each active part of a cell, each cell, each tissue and each organ contributes products which may affect the activities of functionally related or unrelated parts. Hence would follow the dictum that *not only is every part of a cell, every cell, every tissue and every organ an individualized stereochemic unit, but also that its operations, and hence the nature of its products, must be subject directly or indirectly to the influence of every other active part of the organism, however different the structures and functions may be.*

C. The Germplasm a Stereochemic System, that is, a Physico-chemical System that is Particularized by the Characters of its Stereoisomers and the Arrangements of its Components in the Three Dimensions of Space

If during the progress of development there arise the multiple forms of differentiated protoplasm that are represented in the nerve cells, muscles, glands, etc., which exhibit such diversity of form, functions, composition and products, each part being correlated to other parts by the agency of tissue products, it is logical to assume that in the development of the ovaries and testicles these organs have been so specialized as to endow them with the attribute of producing a form of protoplasm that embodies in a germinal state the fundamental peculiar stereoisomerides and the peculiar arrangements or phases of the associated proteins, fats, carbohydrates and other substances which inherently characterize the organism; and, moreover, that owing to the influences of the products of activity of the various tissues upon these organs, such changes in the organism as give rise to acquired characters may through the actions of modified or new tissue products or foreign substances affect the operations of these organs and thus alter the germplasm and consequently become manifested in some form in the offspring. The ovule in its incipiency is conceived to be comparable to a complex unequilibrated solution in which changes go on until the attainment of full development, at which time it is equilibrated and remains inactive because of the absence of some disturbing influence, but in which energy-reactions may be initiated physically, mechanically or chemically, and proceed according to definite physico-chemical laws in definite directions to a definite end. As, for instance, when a solution of boiled starch and diastase is at a temperature below the minimal of activity and the temperature is raised, causing immediate developmental activation; or when the equilibrated molecules of nitroglycerine are exploded by percussion; or when an equilibrated maltose-dextrose-maltase solution is rendered active by dilution with water.

The *nature of the germplasm* or transmissive material that serves as the bridge of continuity between parents and offspring has been the subject of speculation from time immemorial. Such hypotheses and theories as have been advanced have had reference almost wholly to its physical constitution or ultimate morphological structure. Most of them are micromeric, that is, they hold that the germplasm is made up of infinite number of discrete ultramicroscopic particles which are endowed with both determinate structural and vital attributes. A considerable degree of ingenuity has been displayed in their formulation. Thus, we have the "organic molecules" of Buffon, the "microzymes" of Bèchamp, the "life units" of Spencer, the "plastidules" of Maggi, the "bioplasts" of Altmann, the "stirps" of Galton, the "gemmules" of Darwin, the "biophors" of Weismann, the "pangens" of DeVries, etc., each author attributing to the units certain inherent peculiarities. To the foregoing might be added particularly the conceptions that belong to the chemical category, such as the "chemism" of LeDantec and the "physico-chemical" theory of Delage. Some of these conceptions are so fanciful in the light of modern science as to be unworthy of more than passing consideration, while none of them has led anywhere beyond the field of speculation and reasoning. Even the very recent and extremely interesting and important additions to our knowledge of the histological phenomena of the developing ovum, especially of the chromosomes, have not taken us appreciably nearer the ultimate constitution or mechanism of the germplasm, or even to the nature of the reactions which occur immediately antecedent to and cause the formation of the chromosomes.

A theory to be *ideal* must not only have as its basis well-defined principles that are consistent with facts, but also be capable of substantiation by laboratory investigation. Given as the basis of scientific study a germplasm that has inherently the power of development; that is in the form of a stereochemic system that is peculiar to the organism; that is highly impressionable to stimuli; and that has the

marked plasticity that is inherent to organic colloidal matter, we have all the postulates that are needed as a foundation upon which, according to the laws of physical chemistry, can be built a logical explanation of the essential fundamental elements of the mechanism of heredity.

The *inherent potentiality* that determines the development of the egg along a line of definite sequential processes must be recognized as being common to both animate and inanimate matter and subject to the same laws, so that the phenomena of living and dead matter are inseparably linked and reciprocally explanatory. The typical condition of matter of definite composition is crystalline, and the crystalline form is the result of development that becomes manifested in a separation and orderly and progressive arrangements of components in the three dimensions of space. Having a homogeneous solution of various selected crystalline substances of appropriate chemical composition and constitution, and given conditions attendant to crystallization, the successive stages of crystalline development will proceed along fixed and definitely recognized lines, and the interactions and interaction-relationships between the various substances constituting the physico-chemical mechanism become obvious to a greater or less extent in the peculiarities of form, composition and other properties of the crystals. Having in the germplasm an analogous physico-chemical system, but one which is markedly different especially because of its organic and colloidal character and infinitely greater molecular complexity and sensitivity, the phenomena of development likewise proceed in conformity with the same laws along definite lines, but they are for perfectly manifest reasons more complex and varied, more difficult of analysis, and necessarily in many very important respects quite different. Each step in this orderly development leads not merely to changes of the physico-chemical mechanism by the modification, rearrangement, or splitting off of component parts, but also to alterations which automatically determine the characters of the next succeeding step, and so on to the establishment of physico-chemical equilibrium and the consequent termination of the reactions.

In living matter the chemical processes are dependent to a preeminent degree upon enzymes that are formed by the different kinds of protoplasm to serve as implements to carry out operations that are essential to their existence, and such enzymes are modifiable in quantity and quality in accordance with changes in internal and external conditions. The nature of both reactions and products of enzymic action depends upon the constitution and composition of the physico-chemical mechanism of which the enzyme is an integral part. Whether or not at each step of serial reactions a portion of preexisting enzyme is merely modified or a new enzyme is formed which constitutes an essential part of the particular phase of the reactions is not known, but that one or the other occurs is apparently without question. It has long been established that some of the lower organisms, such as the yeast plant, have the property of modifying the characters of the enzymes produced in relation to varying conditions; recent studies of the animal organism show that the same phenomenon occurs in both tissues and blood; and our knowledge of the processes concerned in the catabolism and anabolism of complex substances, such as starch, is fully in support of such a conception. In other words, as each step of development is reached the alterations which occur in the physico-chemical mechanism absolutely automatically predetermine the characters of the changes of the next succeeding step, and so on to the end. Hence it follows that the peculiarities of any given physico-chemical mechanism predetermine the characters of the phenomena which ensue under given conditions.

An illustration of the probable *modus operandi* of such a mechanism is found in the phenomena of the synthesis and analysis of starch: During the production of starch through the agency of the chloroplast or leucoplast we conceive that there are instituted a predetermined, orderly, independent and interdependent series of reactions, the first

of which is manifested in an interaction between water and carbon dioxide through the agency of an enzyme in the form of an oxidase to form formaldehyde. During this process there is formed another enzyme, which tentatively may be designated an aldehydase, that reacts with formaldehyde and by polymerization and condensation of six molecules gives rise to a simple sugar, such as dextrose. At the same time another enzyme appears in the form of maltase, which, reacting with the dextrose causes the formation of maltose, during which reaction another enzyme, a dextrinase, is produced which reacts with the maltose to yield dextrin. Going on with this reaction, another enzyme which may be designated an amylase appears, which, reacting with the dextrin, forms soluble starch. During this stage there arises another enzyme, a coagulase, which converts the starch from the soluble to the insoluble form or ordinary starch. At this stage the series of reactions have reached their end because a state of physico-chemical equilibrium has become established, the ultimate purpose of the processes being attained; that is a form of pabulum of extremely high nutritive value and of extremely low molecular pressure, even in soluble form, so that it may entirely and rapidly disappear without disturbance of physico-chemical equilibrium in the starch-bearing cells. The mechanism concerned in starch-formation is without doubt paralleled in the synthesis of proteins, fats and other complex organic substances, and it is but a step from the individual serial processes concerned in the formation of each of these substances to associated processes whereby there are formed and combined the various substances that constitute the organic structural components of protoplasm. Moreover, such serial processes are reversible at any stage, and so simple a modification as a change in the per cent. of water may, as in the maltose-dextrose-glucase reaction, cause a synthetic change.

In vitro in both synthetic and analytic processes like those which constitute serial steps in the building up and breaking down of starch, protein, fat and other complex organic substances there does not occur in any reaction, as far as known, either a transformation or a production of enzyme such as occurs *in vivo,* hence, when a single enzyme is present it carries out but one step of the reactions, but when, as in the case of diastases as ordinarily prepared, the enzyme is not a single substance or unit body but a composite of a number of enzymes or modifications of a given basic enzyme, serial steps may occur as *in vivo.* Thus, if only a single enzyme be present formaldehyde may be converted into a monosaccharose, or a monosaccharose into a disaccharose, or a disaccharose into a polysaccharose such as dextrin, or dextrin into a higher form of polysaccharose such as soluble starch, according to the enzyme or modified enzyme and initial substance present; or the reverse of any one of these processes may occur if proper conditions are present, but never do any two successive progressive or regressive steps occur unless through the agency of two different or modified forms of enzymes which are present.

It will thus be apparent that the first step of synthesis is determined by the character of the initial physico-chemical mechanism and that all subsequent reactions under given conditions are definitely predetermined; in other words, the entire train of reactions depends inherently upon the nature of the initial physico-chemical mechanism of which the enzyme that starts the serial changes is an integral part.

Having a specific stereochemic system, such a system in accordance with the laws of physical-chemistry can exist in either a latent or active state, and that when in an active state the reaction or reactions are always in the direction of the establishment of equilibrium of solution, every reaction or series of reactions being as definitely predetermined as is every reaction familiar to the inorganic chemist. The germplasm in the form in which it is secreted may be regarded as being in the nature of an exceedingly complex stereochemic system which is from its incipiency, or very soon is in a state of physico-chemical unequilibrium, and in which, as a consequence,

reactions are set up which are manifested especially in histological developments that ultimately characterize the fully developed ovule, at which time a state of physico-chemical equilibrium is established, as is evident by the arrested developmental activities. This state of physico-chemical equilibrium of the matured ovule may be instantly changed to one leading to serial definitely predetermined reactions by means of an activating substance or condition, such as certain ions or inorganic salts, a spermatozoon, or a needle prick, by initiating the first step of the reactions, the nature of the succeeding reactions being predetermined primarily by the inherent nature of the physico-chemical system and secondarily by the factor that activates it. In other words, from this initial stereochemic system there arises a complex heterogeneous system that ultimately is morphologically expressed in the histology of the matured ovule and from which are formed a composite of correlated, independent, interdependent and differentiated masses which represent different phases of the components of the initial system which have been modified not only physico-chemically as expressed by changes in physical, mechanical and chemical properties, but also in developmental energies; and from this composite are developed successively other systems.

Owing to the *great impressionability and plasticity* of such an exceedingly complex stereochemic system as the germplasm, it follows that the germplasm must be extremely sensitive to changes in internal and external conditions, and that its operations and products may be so materially modified by changes in its molecular arrangements or components as to give rise to variables that are manifested in the transmutability of sex, variations, fluctuations, mutations, deformities, retrogressions, tumor formation, immunities, etc.

Assuming in accordance with our conception that the germplasm is in its incipiency an unequilibrated stereochemic system that is characteristic of the inherent, fundamental stereochemic system of the parent, it follows, as a corollary that, having a highly specialized form of parental structural material with peculiar energy-properties, the offspring must of necessity possess essentially the same fundamental characteristics as the parents when normal fecundation has occurred, and that it would be quite as impossible to have any other result than in ordinary chemical reactions under given conditions of experiment. The essential characters of the building material as regards substances, arrangements and energy-properties are definitely fixed within narrow limits of variation.

That the peculiar forms of stereoisomerides or intimately related bodies that are inherent in the parent are conveyed in the germplasm to the offspring, and hence of necessity serve to distinguish a given form of germplasm from that of any other species or genus, and that the stereochemic conception of the nature of the germplasm is capable of laboratory demonstration, are instanced in the results of the investigations of Kossell and his students who found that simple forms of protein, known as protamins, obtained from the spermatozoa of different species of fish are different, each being apparently of a form peculiar to the source. Here is one substance at least that seems to be in specific stereoisomeric forms in the sperm of different species, which obviously must affect the properties of the germplasm, and which when brought in contact with the germplasm of the egg play its part in determining the phenomena of development. Moreover, by the "precipitin reaction" method Blakeslee and Gortner have found evidence that is consistent with the conclusion that there are not only "species proteins" but also "sex proteins," and this receives support in a number of very recent investigations, especially those of Steinach, who found that the corresponding hormones secreted by the ovaries and testicles are different, and that by virtue of these differences the secondary sexual characters, female and male, are determined. Thus he found in castrated young males, in which transplantation of ovaries had been practised, that the development of masculine peculiarities is inhibited and female traits substituted, so that the individuals tend to assume the

female type and become to a striking degree feminized-males, as shown in bodily form, in a development of the mammary glands, in lactation, and in an alteration of psycho-sexual characters. Furthermore, Riddle has found that the ova of the pigeon are dimorphic, one males and the other half females; that the eggs having the male tendency have a higher per cent. of water, a smaller size, and a lower half having an inherent tendency to produce males and the other half females; that the eggs having the male tendency have a higher per cent. of water, a smaller size, and a lower per cent. of potential energy; and that the "sex-foundation" of the germplasm is transmutable, so that an egg that has inherently the male tendency may become female, and that such females exhibit secondary male sexual characters. The transmutability of the germplasm is comparable in its physico-chemical mechanism to the reversion of the maltose-dextrose-maltase reaction that is caused by a change in concentration of the solution, the dextrose being reverted into iso-maltose and not to the antecedent maltose—the male egg is not changed into a female egg, but into a modified or feminized-male egg.

In considering the transmissibility of parental substances it is essential to distinguish positively between the stereoisomerides and intimately related bodies that are *inherent* in the parent and those which are *acquired* through infection or otherwise. Thus anti-bodies that are acquired by the mother may be without influence upon the ovary during the formation of the germplasm and not even become a constituent of the latter. On the other hand, an immunity may be established in the mother that may be conveyed to the offspring, yet, curiously enough, such an immunity may not be transmitted by the immunized male. In processes of the production of the germplasm the ovary may be as insensitive to the presence of many acquired substances of the blood as are some or all other organs, and there is no more reason in general for expecting the ovary and its product to be affected by such bodies or conditions than there is for the pancreas and the pancreatic juice or any other secretory structure and its product to be affected. Every acquired substance must in its relations to the ovaries be governed by the same physico-chemical laws as determine specific selectivities or reactivities in connection with the tissues generally. Hence, any such substance may be reactive in relation to one structure, but not to another.

Plasticity as regards sex-determination has been demonstrated in the studies of the development of a male (drone) bee from the unfertilized egg, and of a female from the fertilized egg. Moreover, the developing female bee when fed on ordinary food becomes a common female "worker," but when fed on royal food develops into a queen.

The *continuity of the building material* between parent and offspring is seen in its simplest manifestations in reproduction among protozoa by binary fission and budding, by which the part separated from the parent mass is in all essential respects like the parent, having the same fundamental physico-chemical composition and constitution. That in such instances the offspring should be a segmental counterpart of the parent mass seems as obvious as that halves of a cube of sugar should be alike. Similarly, if we have in the ovule and sperm forms of protoplasm which as stereochemic systems are in all fundamental respects counterparts of those from which the parents were developed, it follows that the offspring must under normal conditions in accordance with the laws of physical chemistry have the same fundamental parental characteristics, as much so as separated portions of any complex stereochemic system must possess the properties of the initial mass. Moreover, if the stereochemic systems of germplasms of the female and male differ, as must be admitted, it is manifest that the stereochemic system of the egg that has been activated artificially or naturally, as the case may be, must be different, and hence undergo development differences that will be obvious in the offspring. In the first instance, the serial reactions which lead to the formation of the different tissues, etc., are activated by a mere disturbance of physico-chemical equilibrium, which may be due to the conversion of a proenzyme into enzyme or a prosecretin to a secretin, or in

other words of an inactive body into an active one. In the second instance, there is not only activation, but the extremely important addition of the male stereochemic system which by admixture with the female system constitutes a female-male system. Therefore, in the first place the offspring is developed solely from the female stereochemic system, and in the second place from the combined female and male systems, one or the other of which may be wholly or in part dominant in determining certain peculiarities in the developmental changes. Moreover, owing to the transmutability of stereoisomerides and the multiphase transmutability of stereochemic systems, coupled with the reversibility of metabolic processes which may be due to even the simplest of changes in physico-chemical mechanisms, we have a logical basis for the explanation of the phenomena of sexual dimorphism that is expressed in the so-called male and female ova, and male and female spermatozoa; of primary and secondary hermaphroditism; of paradoxical sex developments where the unfertilized egg develops into either male or female offspring; and of sexual transmutability of the inherently male or female ovule.

It follows upon the basis of our theory that because of the inherent peculiarities of the stereochemic systems of the germplasms and the definitely predetermined nature of the entire series of reactions in accordance with the laws of physical chemistry that "like begets like" because like every other physicochemical phenomenon, individual or serial, under given conditions, it is *a physico-chemical fatality*.

Edward Tyson Reichert
University of Pennsylvania

THE CONTENT AND STRUCTURE OF THE ATOM[1]

This lecture has presented to you a vision of the recent struggle toward a better knowledge of the atom. Both experimental results and theory have been briefly discussed. You can readily place confidence in the former, but in the realm of theory you are unable to distinguish truth from error. I have brought to you, then, not the satisfaction which one enjoys in believing he hears the final truth, but rather the discontent with which the scholar views the limitations of knowledge in his field. Such discontent gives birth to zealous endeavor to learn new truth and is thus the precursor of that research in science which our society is organized to encourage. An attempt to think in sub-atomic terms very quickly makes one conscious of the limitations of our knowledge. But I wish to emphasize that such limitations occur in all sciences and, indeed, at any point that a scholar chooses to make his special study. These limitations are not usually easy to extend, especially in the older sciences. And just such difficulties furnish the challenge of scholarship in science to the young men and young women of ability.

There is, however, no need to offer explanations to those who are dissatisfied with a discussion in which truth and error can not be separated. The unscientific mind possesses but two compartments, one for truth and one for error, and such a mind has no compartment in which to place a discussion of the nature and structure of an atom. The scientist, however, recognizes no such compartments, for absolute truth and absolute error are unknown to him. After weighing the evidence furnished, his decisions consist only in selecting the degree of his confidence that is merited by that evidence.

Having given you a bird's-eye view of the evidence, it may now be appropriate to present a brief résumé in perspective of the great achievements in science which have been the subject of this lecture. We can now regard the existence of the sub-atomic electron with as much confidence as that given any other experimental fact in physics. There is yet a question as to whether or not the electron actually is our smallest unit of negative electricity, but the affirmative evidence is much the greater. The mass of the electron can be called "apparent," with the restriction that we know this to be true only to the de-

[1] The closing portion of the address of the retiring President of the Iowa Chapter of Sigma Xi, delivered on October 14th.

gree of accuracy of the experiments. But one can be fairly confident as to the electrical character not only of the electron, but also of the entire atom, for there is much evidence in favor of such a view and none that is contradictory. The conception of a nucleus, as given in the Rutherford theory, is so well verified in the experiments in the deflections of the alpha-particles, the velocity of the struck atom, and the high frequency spectra and in the splendid use made of it by Bohr's theory, that it will probably remain, suffering but little change in the future. It is reasonable to believe that the charge of the nucleus is a natural atomic unit, supplanting the atomic weight in determining the position of an element in the Periodic Table, as now understood. This suggested important function of the nucleus charge seems to afford an explanation for the existence of "isotopes," or elements occupying the same position in the Periodic Table, possessing the same chemical properties and giving the same spectrum, but exhibiting different radio-activities. Moreover, it is becoming more evident that our conception of the atomic weight as a natural unit is incorrect, that the atomic weight is merely the resulting apparent mass of the atom, or practically of the nucleus, and that this apparent mass is not merely the sum of the apparent masses of the charges in the nucleus considered separately, for the apparent mass of a charge is influenced by the proximity of other charges.

The very valuable theories of atomic structure, especially that of Bohr, can not, of course, command one's complete confidence. Indeed, Bohr's theory has been extended to but a partial investigation of the simplest elements and does not pretend to be complete. It possesses great interest because it is a relatively simple effort to account for the exceedingly complex functions of the atom. At the present stage of development of this theory its chief faults are the questioned validity of its assumptions, its lack of uniqueness, and the impossibility of extending it to complex atoms. The question of the validity of the assumptions involved should not be taken too seriously, for any assumptions that will lead to an agreement of theory and experiment will be welcome. The lack of uniqueness need not be a matter of immediate concern, for experimental facts at the present time go far beyond any suggested theory. There is, however, a strong contention on the part of Nicholson that the present theory of Bohr can not be extended to more complex atoms without marked modifications in the present assumptions. But the theory is a remarkable contribution even if it does no more than explain many facts known in the case of the simplest elements. When one contemplates the narrow scope of even this brilliant theory, what a limitless field for research seems ahead! Fortunately, there are at hand a number of methods of investigation that have not yet been fully utilized. Some of the most promising lines of research in this field are the extension of theory into the fields of heat radiation and magnetism and to a larger number of elements, the study of high-frequency spectra, the scattering of swift β particles, the production of Röntgen rays by the impact of positive rays, the low temperature characteristics of elements, and the effects of the magnetic and electric fields upon line spectra. To this might be added a long list of experiments which are more indirect, but which, nevertheless, are very important. An illustration is the investigation of the electrical and optical properties of selenium crystals, which is now being carried on in the laboratory of this university by Doctors Brown and Sieg. Before all these lines of approach are fully occupied new ones will be found, and there is no indication of a cessation of the attack upon the atom for years to come.

Where will the investigation end? It will be without end. Notwithstanding the prospect of such a lively attack upon this problem, one can readily appreciate that progress is likely to be made with much difficulty, taxing all the resources of the physicist and the mathematician. Yet science rarely completes a task before new problems that are more fundamental are found. For example, electricity was first discovered as electrification or strange vari-

ations of matter. The problem of matter was not solved before that of electricity was undertaken. Indeed, through the study of this variation in matter we came to appreciate that in it lay the path to the understanding of the atom. Will this experience now be repeated? Will a variation in the electron, not accounted for by electrical laws, be found, and will an investigation of that phenomenon lead to knowledge of the electron and thus of the atom?

I now desire to direct the attention of the younger members of the Society to two significant points that are illustrated by the material in this lecture. The first is that a problem may be too difficult for a direct attack, and one may need to await discoveries which furnish new and unsuspected clues. Röntgen rays were not discovered for the purpose of studying atomic structure. Neither was such a purpose the cause of experiments which led to the discovery of radioactivity. Thus the scientific worker can never know the future importance of his own work. His motive should be to follow up the most promising clues with which he is favored and to trust that all he accomplishes will be worthy of his effort.

The second point is suggested by the fact that most of the methods of attack here mentioned are comparatively new and probably will never become part of laboratory technique taught in a university curriculum. Method in scientific research is fundamentally not a thing to be learned by graduate or research students. For scientific research is nothing more than the successive application of complete acts of thought to experimental and theoretical problems. One needs but to think and to act.

G. W. Stewart
State University of Iowa

METHODS OF RESUSCITATION

In line with its campaign to reduce the number of deaths in the mines of the United States, the Federal Bureau of Mines some time ago appointed a committee of eminent physicians and surgeons to develop an efficient method of resuscitation to be administered by miners or other persons to a fellow-workman overcome by electric shock or by gases in places which can not be reached by a physician or surgeon in time to save life.

As a result of this committee's report just made, the Bureau of Mines, through Director Joseph A. Holmes, recommends the following procedure in rendering first aid to those in need of artificial respiration.

The recommendations apply not only to men who are overcome by electric shock or gases in mines, but also to persons suffering from the effects of illuminating-gas poisoning or from electric shock anywhere. The recommendations are, therefore, of importance to many thousands of workmen:

In case of gas poisoning, remove victim at once from the gaseous atmosphere. Carry him quickly to fresh air and immediately give manual artificial respiration. Do not stop to loosen clothing. Every moment of delay is serious.

In case of electric shock, break electric current instantly. Free the patient from the current with a single quick motion, using any dry non-conductor, such as clothing, rope, or board, to move patient or wire. Beware of using any metal or moist material. Meantime have every effort made to shut off current.

Attend instantly to the victim's breathing. If the victim is not breathing, he should be given manual artificial respiration at once.

If the patient is breathing slowly and regularly, do not give artificial respiration, but let nature restore breathing unaided.

In gas cases, give oxygen. If the patient has been a victim of gas, give him pure oxygen, with manual artificial respiration.

The oxygen may be given through a breathing bag from a cylinder having a reducing valve, with connecting tubes and face mask, and with an inspiratory and an expiratory valve, of which the latter communicates directly with the atmosphere.

No mechanical artificial resuscitating device should be used unless one operated by hand that has no suction effect on the lungs.

Use the Schaefer or prone pressure method

of artificial respiration. Begin at once. A moment's delay is serious.

Continue the artificial respiration. If necessary, continue two hours or longer without interruption until natural breathing is restored. If natural breathing stops after being restored, use artificial respiration again.

Do not give the patient any liquid, until he is fully conscious.

Give him fresh air, but keep his body warm.

Send for the nearest doctor as soon as the accident is discovered.

The members of the committee reporting to the Bureau of Mines are as follows: Dr. W. B. Cannon, chairman, professor of physiology, Harvard University; Dr. George W. Crile, professor of surgery, Western Reserve University, Cleveland, Ohio; Dr. Joseph Erlanger, professor of physiology, Washington University, St. Louis; Dr. Yandell Henderson, professor of physiology, Yale University; and Dr. S. J. Meltzer, head of the department of physiology and pharmacology, Rockefeller Institute for Medical Research.

AWARDS OF THE JOHN SCOTT MEDAL

The city of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Elmer Ambrose Sperry, of New York, N. Y., for his gyro compass. On battleships under action, the shifting of large masses of magnetic material precludes the use of the magnetic compass, and even on ordinary iron vessels, the material of the ship and its disposition must be compensated for. The gyro compass is entirely non-magnetic and is unaffected by the proximity of iron. For some years Mr. Sperry has devoted practically his whole time to overcoming the numerous physical difficulties involved in the adaptation of a gyroscope to a ship's compass in the place of a magnetic needle. He has been able to make an instrument which automatically corrects for the speed and direction of the vessel, and which is unaffected by the rolling of the ship in a heavy sea. His compass may be made in the form of a master compass which may be made to actuate secondary or repeater compasses mounted in any desired part of the vessel. On naval vessels, such an arrangement is very desirable, as the master compass may be installed behind heavy armor plate and protected from damage, and may still be available when all the secondary compasses are destroyed.

An award of the John Scott Legacy Medal and Premium has also been made to Arthur Atwater Kent, of Rosemont, Pa., for his "unisparker." The unisparker is an essential element of the Atwater Kent Ignition System for automobiles, and consists of a contact-breaker, governor and distributor, arranged in one structure. The contact-breaker is in the primary of a non-trembler coil circuit and is so designed as to be operative only when the engine runs in one direction, thus preventing backfiring. The governor automatically advances and retards the spark according to the requirements of the engine. The distributor is in the secondary circuit of the coil and distributes the sparks to the several cylinders. All the parts of the device are especially designed for durability. The contact points are of tungsten and are of large area. The current in the primary circuit can be reversed at will, changing the polarity of the contacts and preventing their disintegration.

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

In January, 1915, the National Academy of Sciences will begin the publication of Monthly Proceedings. The members of the editorial staff, with the fields of science represented by them, are:

Astronomy: E. B. Frost, Yerkes Observatory, Williams Bay, Wis.

Mathematics: E. H. Moore, University of Chicago, Chicago, Ill.

Physics: Henry Crew, Northwestern University, Evanston, Ill.

Chemistry, Biological and Organic: J. J. Abel, Johns Hopkins University, Baltimore, Md.

Chemistry, Physical and Inorganic: A. A. Noyes, Mass. Inst. Tech., Boston, Mass.

Geology: H. F. Reid, Johns Hopkins University, Baltimore, Md.

Paleontology: Charles Schuchert, Yale University, New Haven, Conn.

Botany: J. M. Coulter, University of Chicago, Chicago, Ill.
Zoology: R. G. Harrison, Yale University, New Haven, Conn.
Genetics: C. B. Davenport, Cold Spring Harbor, N. Y.
Physiology: W. B. Cannon, Harvard University, Cambridge, Mass.
Pathology: Simon Flexner, Rockefeller Institute, New York City.
Anthropology: W. H. Holmes, National Museum, Washington, D. C.
Psychology: J. McKeen Cattell, Columbia University, New York City.
Ex-officiis:
Home Secretary, A. L. Day, Geophysical Laboratory, Washington, D. C.
Foreign Secretary, G. E. Hale, Solar Observatory, Pasadena, Cal.
Managing Editor: E. B. Wilson, Mass. Inst. Tech., Boston, Mass.
Chairman of the Board: A. A. Noyes, Mass. Inst. Tech., Boston, Mass.

The main purpose of the proceedings is to obtain the prompt publication and wide circulation of a comprehensive survey, in the form of brief original articles, of the more important scientific researches currently made by American investigators. The articles are to be much shorter and less detailed than those commonly published in special journals, and may subsequently be published in more extensive form in such journals. It is expected that the articles will as a rule vary from one to five printed pages in length, with a maximum limit of eight to ten pages in exceptional cases where the results of extended investigations are summarized, or the significance of a series of detailed publications is formulated. The articles are, however, to be precise, and to contain some record of the experimental, observational, or theoretical methods and results upon which the conclusions are based; but these statements are to be condensed, long tables of data and the details of the work being reserved for publication in special journals.

SCIENTIFIC NOTES AND NEWS

The Bisset Hawkins memorial medal, awarded triennially by the Royal College of Physicians of London, in recognition of work in advancing sanitary science or promoting public health during the preceding ten years, was, on October 19, presented to Sir Ronald Ross, in recognition of his researches on malaria.

The Technical Institute at Zurich has conferred its honorary doctorate on Professor Hermann Schwartz, professor of mathematics at Berlin, on the occasion of the fiftieth anniversary of his doctorate.

Dr. Joseph P. Iddings is engaged in geological research in the far east, having been in Java in August. He does not expect to return to Washington for a year or more.

Dr. J. William White, emeritus professor of surgery at the University of Pennsylvania, and Dr. R. Tait McKenzie, head of the department of physical education, have volunteered their professional services to the British government.

Mr. Millard K. Shaler, who is representing the United States in affording relief to suffering Belgians, was, until 1909, a member of the U. S. Geological Survey, since which time he has been engaged in explorations in the African Congo region.

Several German scientific men, including the botanist Dr. Kukenthal, who were engaged in a scientific expedition to Corsica, are said to be held prisoners of war on the island.

Dr. R. Trumpler, astronomer for the Geodetic Commission of Switzerland, has been appointed assistant at the Allegheny Observatory, but has thus far been detained, being an officer in the Swiss army.

Dr. George H. Shull has returned to the Station of Experimental Evolution, Cold Spring Harbor, N. Y., after spending thirteen months in Berlin. He carried on some experiments in Dr. Erwin Baur's botanical garden in Friedrichshagen, and at the outbreak of the war was able to assist in the other experimental work. Previously he took part in the meeting of the German Botanical Society, and by invitation gave an address on heterozygosis in its bearing on practical breeding before the Society for the Advancement of

German Plant Culture at its annual meeting, held this year at the University of Göttingen.

Dr. A. M. Patterson has resigned as editor of *Chemical Abstracts,* and Dr. J. J. Miller has been elected editor and Dr. E. J. Crane, associate editor of the publication.

On November 1, Dr. C. W. Stiles changed stations from the U. S. Marine Hospital, Wilmington, N. C., back to the Hygienic Laboratory, Washington, D. C. His address until further notice will be: Hygienic Laboratory, 25th and E Streets, N. W., Washington, D. C. All communications intended for the International Commission on Zoological Nomenclature should be sent to that address.

Dr. Harvey W. Wiley celebrated his seventieth birthday on October 18 by a dinner party, the guests at which included Professor Charles E. Monroe, who was one of Dr. Wiley's instructors at Harvard University; Dr. W. D. Bigelow, for many years associated with Dr. Wiley in the bureau of chemistry; Dr. G. L. Spencer, who was a student under Dr. Wiley when he taught at Purdue University 40 years ago, and who is widely known as a sugar engineer, and Professor Frank W. Clarke, of Washington.

In recognition of his work on the fossil birds in the collection of the Peabody Museum of Yale University, Dr. R. W. Shufeldt, of Washington, D. C., was, at the regular meeting of the Connecticut Academy of Arts and Sciences held on October 28, elected an active member of that society. The society has accepted for publication the aforesaid work, it being a description of the fossil birds in the Yale collection, including a revision of all of Professor O. C. Marsh's types (exclusive of the *Odontornithes*), and other material left undescribed by him. Several new genera and species of extinct birds are described for the first time.

Dr. Irwin Shepard, for twenty years secretary of the National Education Association, has for the past fifteen months been connected with the Panama-Pacific International Exposition as national secretary of the bureau of conventions and societies. He has been associated with James A. Barr, director of congresses, in the work of arranging for a world series of congresses, conferences and conventions. On September 11, he was compelled for reasons of health, much to the regret of the exposition authorities, to retire from the active work of the bureau.

A series of lectures on "Sanitation as Applied to Cities" is being given at the Worcester Polytechnic Institute on Monday and Friday afternoons during November by Professor George C. Whipple, of Harvard University. The dates and subjects of the lectures follow:

November 2. "The Value of Municipal Cleanliness."
November 6. "Clean Air."
November 9. "Clean Water."
November 13. "Disposal of Liquid Wastes."
November 16. "Disposal of Solid Wastes."
November 20. "The Economics Factor in Sanitation."
November 23. "The Social Factor in Sanitation."

A course of eight public lectures is being given in the botanical department of University College, London, on the rôle of plants in the protection and growth of the shore, by Professor F. W. Oliver.

The Harveian Oration, delivered before the Royal College of Physicians of London on October 19 by Sir R. Douglas Powell, dealt with advances in knowledge regarding the circulation and attributes of the blood since Harvey's time.

On October 30, Professor J. C. Bose, of Calcutta, gave a lecture before the Royal Society of Medicine, London, on the modification of response in plants under the action of drugs.

The second Thomas Hawksley lecture was delivered in the meeting hall of the Institution of Mechanical Engineers on October 30, by Mr. W. B. Bryan, the subject being "Pumping and Other Machinery for Waterworks and Drainage."

The family of Emil du Bois Reymond has donated the Helmholtz gold medal to the relief fund, with the statement that this medal, repre-

senting the highest appreciation in his own land of the scientific achievements of du Bois Reymond, is honored more by devoting it to the service of the country than by preserving it.

We learn from *Nature* that the opening meeting of the new session of the Institution of Electrical Engineers, London, will be held on Thursday, October 29, when the president, Sir John Snell, will deliver his inaugural address. At this meeting a marble bust of Michael Faraday will be presented to the institution by Mr. Llewellyn Preece, on behalf of the family of the late Sir William Preece, past president.

Dr. George Livingston Peabody, formerly a prominent New York physician, died suddenly at his home in Newport on October 30. Dr. Peabody, who was in his sixty-fifth year, graduated from Columbia College in the class of 1870, and from its College of Physicians and Surgeons in 1873. He was lecturer in medicine in the college from 1884 until 1887, and then became professor of materia medica and therapeutics, which post he held until 1903.

Dr. Frederick König, professor of surgery at the university of Marburg, was killed recently while attending to the wounded on one of the battlefields at the eastern seat of war. Others who have lost their lives in the war are Dr. Ernst Preuss, docent for machine-testing in the Technological School at Darmstadt, and Dr. Wilhelm Deimler, docent for mathematics in the School of Technology at Munich.

The directors of the American Chemical Society have voted that it is not advisable to hold any general meeting of the society previous to the New Orleans meeting, April 1–3, 1915. They have also voted, in accord with previous invitations presented to the council, that the annual meeting of 1915 be held in Seattle, Washington, with adjournment to San Francisco, the exact date to be settled by the president and secretary after conference with members of the section immediately concerned.

The office of the American Mathematical Society was destroyed by fire on October 10, with loss of records, files and a considerable part of the stock of back numbers of the *Bulletin* and *Transactions*. The society has now no copies of the first ten volumes of the *Bulletin* except the single set in its library. Gifts of any of these early volumes would be greatly appreciated, and also of any copies of the Annual Register. The society's address is 501 West 116th Street, New York, N. Y.

The New York Section of the American Electrochemical Society will hold a joint meeting with the American Gas Institute and the Institute of Illuminating Engineers at the Chemists Club, New York, on Tuesday, November 10. An informal dinner, to which guests are cordially welcome, will be held at the Chemists Club at 7 on the night of the meeting. The program is as follows:

"The Improved Incandescent Mantle," Milton C. Whitaker, Columbia University.

"Chemistry in the Development and Operation of the Flaming Arcs," William C. Moore, National Carbon Co.

"The New Tungsten Lamps," Ralph E. Myers, Westinghouse Lamp Co.

"The Quartz Mercury Lamp," R. D. Mailey, Cooper Hewitt Electric Co.

"The New Moore Tubes," D. MacFarlan Moore, Edison Lamp Works.

After ten years of successful experience, the Mathematical Club of Syracuse University has been reorganized into a mathematical fraternity, Pi Mu Epsilon, whose aims are the advancement of mathematics and scholarship. The fraternity was incorporated under the laws of the state of New York under date of May 25, 1914. The charter members consist of members of the mathematical faculty, graduate students in mathematics and undergraduate major and minor mathematical students. Among the powers granted under the articles of incorporation is that of granting charters to other chapters to be organized elsewhere.

The Royal Canadian Institute in Toronto, Canada, plans to inaugurate work on the lines of the Mellon Institute of the University of Pittsburgh. Dr. Raymond F. Bacon, director of Mellon Institute, has been invited to speak before the Canadian Institute this month. The University of Toronto has been selected for this meeting because the late Dr. Robert

Kennedy Duncan, founder of the system of industrial research in Pittsburgh, was a Canadian and a graduate of the University of Toronto. The Dominion of Canada Royal Commission on Industrial Research visited Pittsburgh about a year ago to study the institute. The report of the commission indicated that work such as that done by the Mellon Institute was as urgently needed in Canada as in the United States.

The surgeon general of the army announces that preliminary examinations for appointment of first lieutenants in the Army Medical Corps will be held on January 11, 1915, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to secure an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held simultaneously throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. In order to perfect all necessary arrangements for the examinations, applications must be completed and in possession of the adjutant general at least three weeks before the date of examination. Early attention is therefore enjoined upon all intending applicants. There are at present twenty vacancies in the medical corps of the army.

A valuable collection of ethnological specimens has just been received by the University of Pennsylvania Museum from Dr. William C. Farabee, who is at the head of the university's Amazon expedition. The specimens were collected in the southern part of British Guiana among the Carib and Arowak Indians and other hitherto unknown tribes. They include clothing for men and women, made from the feathers of the Macaw and other birds of rich plumage, paintings of religious ceremonials, on sticks, beadwork, bows and arrows, spears, hammocks and domestic utensils.

Miss Sue Watson, of Pittsburgh, artist of the department of anatomy in the School of Medicine, University of Pittsburgh, has been appointed by Governor John K. Tener, to make four panels, which will stand above the main entrance of the Pennsylvania State Building at the Pan-Pacific Exposition. This is the second award that Miss Watson has received for public work of this kind, the first one having been the award for decorative work on the new Schenley Theater.

The Royal Photographic Society has, as we learn from *Nature,* opened to the public a house exhibition of photographs by Mr. Lewis Balfour, "Bird Life on the Bass Rock." There are upwards of one hundred of these pictures showing the various sea birds and incidents in their lives.

A movement has been set on foot in Holland for a resumption of scientific exploration in the Dutch East Indies, in the region between Celebes and New Guinea, particularly in the island of Ceram. At the end of last year the matter was referred by the president of the Royal Netherlands Geographical Society to the Expedition Committee, which, after fully considering the question, reported to the Council of the Society in March, 1914. The committee, which included various gentlemen who have taken part in previous scientific research in that region, enjoyed the cooperation of other experts, and from a study of all existing information, drew up a statement on the present state of our knowledge of the part of the Archipelago between Celebes and New Guinea, which is considered to offer an important field for further research. This statement, together with the report of the committee, is taken by the *Geographical Journal* from the May number of the *Tijdschrift* of the Netherlands Geographical Society. As regards the large island of Ceram, it is pointed out that existing knowledge of its topography is scanty, and, for the interior of the eastern part, practically nil.

From a geological point of view much valuable information would result from a study of the double bridge of islands between Celebes and New Guinea—the more northerly running through Pulo Peling, the Banggai archipelago, the Sula Islands, Pulo Obi and Misol, to the so-called "duck-bill" of New Guinea; the more southerly through Buru and Ceram to Fakfak. This is, in fact, one of the most important and interesting tasks remaining to be done in the archipelago. A detailed examination of the geology of Ceram, known to us only through the work of Martin and Verbeek, would be of both scientific and practical value. In the domain of hydrography and oceanography there is much to be learned in the region round Ceram, and the program would include surveys, soundings, studies of the tides, currents, temperature and composition of the water, and the fauna and flora of the coast, the coastal waters, and the deep sea. Little is also known of the inhabitants of the interior of Ceram, their relationships among themselves and with the coast peoples, their languages, and so on. The zoology and botany of the island offer a wide field for research, and in conjunction with the geology should throw an important light on the past history of this part of the world. The flora of Central Ceram is considered to be probably the oldest member of the flora of the Moluccas. The proposed investigations promise results of great scientific interest.

THE United States Geological Survey has just printed a large, colored wall map showing the petroleum resources and the natural gas deposits of the United States, and also the thousands of miles of trunk oil pipe lines. The map shows the areas underlain by known oil pools and known gas pools, as well as general localities which are productive in either oil or gas, and also areas where there are noteworthy occurrences of either oil or gas but where there is no present production. The map is 49 by 76 inches, printed on the scale of 40 miles to 1 inch, in 5 colors. It is printed in two sheets and is sold by the Geological Survey. This map not only shows graphically the oil fields and pipe lines, but is an excellent general map of the United States.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $10,000 has been made to Brown University from the Philadelphia alumni for the purpose of establishing the "Morgan Edwards Fellowship."

THE council of the University of Paris has made all arrangements for beginning courses in the various departments at the usual date.

THE St. Louis College of Pharmacy will celebrate its semi-centennial on November 10 and 11, with appropriate exercises, participated in by prominent pharmaceutical educators from different sections of the country.

THE extension of the certificate privilege to accredited high schools and preparatory schools has resulted in an increase in the number of students in the freshman class entering Stevens Institute this fall of eighty-three per cent. over the number entering last year.

DR. WALTER PEARSON KELLEY has been appointed professor of agricultural chemistry in the graduate school of tropical agriculture and citrus experiment station of the University of California. Woodbridge Metcalf has been appointed assistant professor of forestry in the university, and Dr. Wilbur A. Sawyer, director of the California State Hygiene Laboratory, has been appointed lecturer in hygiene and preventive medicine in the medical school.

DR. CORNELIUS COPLEY has been appointed professor of laryngology in the College of Physicians and Surgeons, Columbia University, to succeed the late Dr. William K. Simpson.

MR. M. A. CHARAVAY, instructor in experimental engineering, in the Stevens Institute of Technology, has been appointed assistant professor. Mr. C. Lester Coggins, of the department of physics has accepted an assistant professorship at Rhode Island State College. Mr. L. C. F. Horle, a graduate of Stevens, has been appointed assistant in physics in his place.

DR. HOWARD THOMAS KARSNER, B.S., M.D. (Pennsylvania), now assistant professor of pathology in Harvard Medical School, has been appointed professor of pathology in the school of medicine, Western Reserve Univer-

sity, and will begin his duties December 1, 1914. The following additional full-time instructors began service this year: Henry O. Feiss, A.B., M.D. (Harvard), D.Sc. (Edinburgh), in experimental medicine; Gaius E. Harmon, M.D. (Boston), C.P.H. (Mass. Inst.), in hygiene; Bradley M. Patten, A.B, Ph.D. (Harvard), in histology and embryology; George E. Simpson, B.S. (Illinois) in organic and biochemistry.

THE following appointments have been made in the department of psychology at the University of Illinois: Dr. Homer B. Reed, instructor; Dr. Joseph E. De Camp, assistant; Miss Anna Sophie Rogers, graduate assistant, and Miss Helen Clark, fellow.

DR. RUDOLF ROTHE, professor of mathematics in the Technical School at Hanover, has been called to the Technical School at Charlottenburg to succeed the late Professor Hettner.

DR. PETER DEBYE, professor of physics at Utrecht, has accepted a call to Göttingen.

DISCUSSION AND CORRESPONDENCE

THE HISTORY OF SCIENCE

TO THE EDITOR OF SCIENCE: During the past months I have written a number of professors, deans and college presidents, as well as directors of institutes of technology, in reference to the value to American undergraduates of the study of the history of the sciences and industries. In each case the response received has been marked by cordiality and enthusiasm; so that I am now encouraged to seek a larger audience than can be reached by private correspondence. May I hope that the columns of your periodical will be open for a discussion of the matter?

Many of my correspondents (whose names, unfortunately, I have not yet sought permission to quote) feel that if in their undergraduate days they had been given a survey of the development of the sciences, or, better still, had been led to trace the evolution of scientific thought, their individual mental progress would thereby have been much stimulated and advanced. They feel, moreover, that such a course of study as I suggest would be of special value in America, where our life and institutions commit us to the ideals of a democratic culture.

It is of course widely recognized that the individual sciences would be better taught if presented on an historical background; we know most vividly what we know in its origins. An old-fashioned course in chemistry taught us that oxygen was a colorless, tasteless, odorless gas, non-combustible, but a supporter of combustion, and left it to later chance reading to disclose the thrilling story of the discovery of oxygen. Those fortunate enough (perhaps years after graduation) to read eventually of the men of genius, Scheele, Priestley, Lavoisier, who had agonized to attain the generalization that had seemed so tame and valueless to the undergraduate, realized the defectiveness of instruction that sought to give the results of scientific investigation without availing itself of the historical motive.

The practise of teaching the sciences in their evolution is a needed modification of Herbert Spencer's pedagogy, without which his theory is both inconsistent and rude. On the one hand, he, like a true follower of Auguste Comte, held that the development of the individual intellect should rehearse the course of the history of civilization; on the other hand, he attacked as too primitive what he called the esthetic and ornamental studies. If he had supplemented his devotion to the sciences (as he understood them) by a recognition of the sciences in their development he would have been more consistent, and perhaps have been less bellicose in his attitude toward those languages in which Archimedes, Lucretius and Galileo wrote. That the history of the sciences was the essential history of civilization and as such should be rehearsed by each developing mind he still could have maintained.

Another defect in the undergraduate curriculum that might be made good by the general history of science is the lack of connection between scientific studies. In the old-fashioned college the student was permitted to take up biology in the freshman year, phys-

ics and chemistry in the sophomore, mineralogy and crystallography in the junior, and geology, astronomy and psychology in the senior. Scarcely a word in reference to the mutual influences and interconnections of these sciences! Only the exceptional graduate was able to bring order out of the chaos of knowledge he bore away with his skeepskin.

Those who attend American institutions of higher learning might easily be made to see in the beginnings of science essential problems in their less complex forms, and realize that organized knowledge arose in connection with industry and human needs. They could be placed in a position to appreciate the present-day applications of science, and to welcome future inventions and discoveries. At the same time they would learn that some of the most abstract reasoners have contributed to racial progress through studies that were not obviously utilitarian. They could be made to understand that science is the constant pursuit of truth and not merely a treasure-house of truth already attained, and incidentally that it is no reproach to science that it does not teach to-day what it taught five hundred years ago, and that Darwin did not live in vain even if what he discovered is also in the process of evolution. As already indicated, our undergraduates through the example of the great scientists should be stimulated to research and independence, and weaned from the childlike notizenstolz of the academic classroom.

Of course in order to be truly cultural a course in the history of the sciences must rise to general ideas, discuss cause and effect, the constitution of matter, and the conceptions fundamental to all the sciences. In a word it must be interpretive and not merely narrative. In fact, the subject of study I am discussing first presented itself to my mind as an equivalent in this institution of the traditional history of philosophy, a means of deepening our culture without prejudice to our confessed practical, vocational aims. It was soon realized that the general history of science affords a unique approach to the history of general thought. The history of philosophy can be reread in the light of the history of science.

For example, we all learned at college that Thales saw in water, or the moist, the principles of all things; but we were not taught at the same time that twenty-three centuries elapsed before men discovered the constitution of water as we understand it, and before it was demonstrated that water could not be reduced to a solid by boiling; that Thales was dealing with what a later time called the states of aggregation of matter; and that liquid, or possibly fluid, might represent his conception. Similarly we studied the theory of the pneuma without knowing that it was late in the eighteenth century that a great chemist published his "experiments and observations on different kinds of air." The nature of the elements, the reality of the concept, the permanence of species, the transmigration of souls and genetic psychology, these topics will suggest to my readers points at which the history of science throws light on the history of philosophy. Indeed whole periods, like the scholastic (with its insistent question: What is the difference between this and that?), assume a new value as seen from the standpoint of the history of science.

Dannemann's work "Die Naturwissenschaften in ihrer Entwicklung und in ihrem Zusammenhange" has the merit of offering a wealth of material on the subject it treats. The fourth volume gives excellent bibliographies of the general history of the sciences, as well as of astronomy, physics, chemistry, mineralogy, geology, zoology, botany, general biology, medicine and hygiene, technology, mathematics, etc. It is far from being an ideal text-book, but it affords a fascinating survey and leaves no doubt in the mind of the experienced instructor that the history of the sciences could be treated in a way highly acceptable to the American undergraduate. It would interest the humblest intelligence, and stimulate the exceptional minds to the heights to which they might be capable of attaining. The tactful instructor would emphasize the narrative or interpretative factors, the practical or philosophical aspects, of the subject, ac-

cording to the abilities of the students. I can think of no better means than that which the history of general science affords of making the accumulated wisdom of the race tell on the active American life of to-day.

The problem of presenting this subject adequately would be greatly simplified if there were in English a good book of four or five hundred pages on the Evolution of Scientific Thought. Let us add, since we are merely expressing a pious wish, that it should be a model of concise and logical exposition written with the charm and lucidity of a Huxley. It should rest on a background of general ideas, and be a philosophy of the sciences; at the same time it should not neglect the applications of science, and should incite an interest in industry and invention.

Some such work is needed by the scientific world as a sort of confession of faith, or canon of the truth it holds and teaches. Without some summary of what investigation has demonstrated the professor has less authority than the clergyman in the minds of young men and women. He is held in general to be an unbeliever, because he is negative rather than positive, destructive rather than constructive, a cold critic of what others teach rather than an enthusiastic exponent of the faith he holds. The professors fail to express what they really think and feel. The mind of the learned world has traveled far from the agnosticism of the middle of the nineteenth century. It is not merely that in reference to traditional faiths scholars do not believe, or believe not; they believe something else. It is too general to say that they believe in education and enlightenment and simple goodwill. It is merely intellectual to proclaim: I believe in the law of gravitation, the nebular hypothesis, the circulation of the blood, the cellular structure of the tissues, organic evolution, the continuity of germ-plasm, the dependence of human thought on nerve tissue, the evolution of mind, and the cure of disease through the development of antitoxins. But when hundreds of such truths are presented historically as the fixed points in a cosmos established by the combined efforts of men, the cumulative effect is to take us beyond a cold intellectual formulation of an ordered universe to an enthusiastic affirmation of the reign of law to be widened by the energies of the generations. Moreover, within its scope come social and ethical as well as physical and other mental phenomena, and through the historical study of ethics and sociology the student is led to see the gradual triumph of beneficent customs and legislation, supported on principles of justice, equity, freedom and good will.

Such a philosophical summary of the history of science introducing the best minds of the continent, perhaps the foremost million of the population, to the vital ideas of the time, seems an almost imperative need of American culture. For in the realm of ideas there is no such thing as spontaneous generation. Those who seem the originators of great movements are those who have been brought under great influences. Apparent exceptions to this rule, like Shakespeare or Darwin or Lincoln, prove, on examination, excellent examples. There is little difficulty in tracing historically the continuity of human thought. It follows that we can not hope for a generation of original thinkers unless we immerse our students in the stream of the world's thought. The most inventive mind must have material on which to react, and can not strike out in a vacuum.

The more or less friendly foreign critics who discuss American culture complain of our exclusive devotion to practical aims, our lack of conversation, and a certain narrowness in our outlook. From one point of view these so-called faults seem as fair as others' virtues. But it is wisdom to recognize the just element in these strictures. Practical considerations alone warn us against narrowness of training. It can be shown from a history of the industries that frequently progress has been opposed by men whose experience has confined them to one department, or to one section of one department. Advances have come here as in the sciences from outsiders. Rightly understood this is a further argument, not for lack of culture, but for breadth of culture. Such freedom of outlook, without any impair-

ment of our robust and practical ideals, can be gained by the study of the work of Faraday, Newton, Kepler, Franklin, Darwin and Pasteur, and the general conceptions on which their work was based.

In conclusion one must recognize that science is international, English, German, French, Italian, Russian, all nations cooperating in the interests of racial progress. Accordingly, a survey of the sciences tends to in-increase mutual respect, and to heighten the humanitarian sentiment. The history of the sciences can be taught to people of all creeds and colors, and can not fail to enhance in the breast of every young man or woman, faith in human progress and good will to all mankind.

WALTER LIBBY

CARNEGIE INSTITUTE OF TECHNOLOGY

SOME INCONSISTENCIES IN PHYSICS TEXT-BOOKS

THE following is a quotation from Kohlrausch's "Physical Measurements":

> The coefficient of capillarity may be *defined* as the weight of fluid which is supported by the unit of length of the line of contact of its surface with a thoroughly wetted plate.

Now a coefficient is a proportionality factor, a pure number expressing the measure of some specified force or property. For example, the volume coefficient of expansion of a gas is the ratio between the increase in volume per degree rise in temperature, and the volume at zero degrees centigrade, the pressure remaining constant. If we keep the expression coefficient of capillarity or capillary constant it must be as the *ratio* between the weight of liquid raised above the undisturbed level and the length of the line of contact of its surface with a thoroughly wetted plate.

In my opinion there is a difficulty with ratios involving quantities measured in different units. It is much simpler, for instance, to grasp the significance of the ratio of the extension of a wire per given or unit tension, to the initial length (see Duff's "Text-book of Physics," p. 122) than of Young's modulus expressed as the ratio of the longitudinal stress to the longitudinal strain; the stress measured as tension per unit cross section and the strain as extension per unit length.

The quotation from Kohlrausch is not in any case a *definition:* it explains how the *surface tension* of a liquid may be *measured.* Capillarity is the phenomenon of rise or fall of liquids in tubes due to the surface tension of the liquids. In most recent text-books and laboratory manuals the term coefficient of capillarity, capillary constant or coefficient of surface tension is not used. Duff, for instance, and Ames in his "College Physics," state this:

> If a line be imagined drawn along the surface of a liquid, the part of the surface on one side of the line pulls on the part on the other side, and if the length of the line be supposed one centimeter the pull in dynes is taken as the magnitude of the surface tension of the liquid.

Another term used inconsistently is *specific.* A specific quantity is concrete and so should be expressed in a unit. But we find specific gavity defined as a *ratio.*

> The specific gravity of a body is the ratio of the mass of any volume of it to the mass of the same volume of pure water at 4° C. (Carhart's "College Physics"). Specific gravity may be defined consistently as the weight of unit volume of the substance (Watson's "Text-book of Physics"). But it is useful to keep in the definition, because of our methods of determining specific gravity, the idea of comparison. Kimball ("College Physics") calls it relative density, defining it as "the ratio between the density of the substance considered and the density of a standard."

The definition of the specific heat of a substance is consistently given, in most recent text-books, as the quantity of heat in calories which will raise the temperature of one gram of a substance through one degree centigrade. The specific inductive capacity of a medium is, however, defined as the ratio between the capacities of two condensers equal in size, one of them being an air condenser, the other filled with the specific dielectric. But this ratio is as often called dielectric constant, sometimes the coefficient of induction.

These points are small ones, but they are puzzling to beginners and always annoying.

SUE AVIS BLAKE

SMITH COLLEGE

CHEMISTRY IN THE AGRICULTURAL COLLEGE

Professor Copeland in a recent article in Science[1] on "Botany in the Agricultural College" states as a minor point that much of the chemistry taught in these institutions is not basic to work in agriculture.

It may be interesting to note in this connection that we have found in this laboratory that it is possible to give freshmen, in a required course in chemistry, work which has relation to agriculture and seems to be of interest to them.

The work is synthetic rather than analytic or descriptive in character, and consists, in part, in preparation from the original sources of the following materials: superphosphate, ammonium sulfate (from gas liquor), high grade muriate and sulfate of potash, as well as the sulfate of potash-magnesia from crude salts, arsenate of lead, lime-sulfur, Bordeaux mixture, Paris green and various emulsions.

A student spends one or more two-hour laboratory periods on one preparation, often using the product of one day's work to make a second substance. For example, copper sulfate is made from metallic copper, and at a following exercise Bordeaux mixture and Paris green are made from the copper salt. Similarly lead nitrate is made from the oxid before the nitrate is used to prepare the arsenate of lead.

Many of these preparations, in the making, furnish excellent opportunities to illustrate the principles of mass-action and some phases of colloidal chemistry.

C. A. Peters

Massachusetts Agricultural College,
Department of General and
Agricultural Chemistry

[1] September 18, 1914, page 401.

THE RENOUNCING OF HONORARY DEGREES

To the Editor of Science: In your issue of October 2, I notice certain German professors have stated their intention of renouncing the honorary degrees conferred upon them by British universities. If they imagine they can do this they are, as regards Cambridge, imagining a vain thing. Our statutes, which are acts of parliament, give no power, even to the authorities of the university itself, to take away honorary degrees.

The utmost the German professors can do is to cease to use them, but they will still remain honorary doctors of Cambridge. They will go down to the tomb with this indelible stain upon their names.

A. E. Shipley

Christ's College,
Cambridge

SCIENTIFIC BOOKS

Telegraphy. By the late Sir W. H. Preece, K.C.B., F.R.S., and Sir J. Sivewright, M.A., K.C.M.G. Revised and partly rewritten by W. Llewellyn Preece. London and New York, Longmans, Green and Co., 1914. 422 pages, 269 illustrations. Price $2.25 net.

This interesting volume in the Text-Book of Science Series is a thorough revision of a smaller volume of 300 pages by the same two authors published by Longmans, Green & Co. in 1876. Although the original volume passed through nine editions, its contents remained almost unchanged. At that time, the book was practically the only one on the subject of telegraphy in Great Britain available for operators and artisans employed in the British post-office system. Great changes have naturally taken place in that system during the 38 years which have passed since the book first made its appearance. The new book has, for instance, to include telephones and telephony, neither of which is referred to in the original edition. On the other hand, it has been necessary to exclude, for want of space, some of the subjects dealt with in the original volume.

In clearness and simplicity of statement, it would be difficult for the new edition to improve upon the old. All the writings of the late Sir William Preece were signalized by their directness and lucidity. His collaborator, Sir James Sivewright, was entitled to a like share of praise for his literary presentations. Between them they wrote a volume that remained, during a generation, a standard for

the class to whom it was addressed. The traditions of the volume have been well supported by Mr. Llewellyn Preece, Sir William's son. While many of the original illustrations have been preserved and reproduced in the new edition, more than a hundred new illustrations have been incorporated.

It is so rarely that we find a man's scientific and literary production adequately brought up to date by the labor of his son, that the book before us would have a claim for recognition on this account alone.

In view of so much new material which has been introduced, it seems invidious to complain of omissions. It is to be regretted, however, that the last chapter of the original edition, devoted to "Commercial Telegraphy" and dealing with the very interesting and special administrative features of the British telegraphs, should have had to disappear, in making up the new volume. There was a characteristic quality in that presentation which we think will be missed in the new edition, and which is valuable to students of telegraphy.

The new chapters on Repeaters, Quadruplex, Multiplex, the Telephone and Wireless Telegraphy are excellent, and the treatment which they offer of those subjects accords remarkably well with the style of the original volume.

A. E. KENNELLY

A History of Japanese Mathematics. By DAVID EUGENE SMITH and YOSHIO MIKAMI. The Open Court Publishing Company, Chicago, 1914. Pp. vii + 288.

This interesting story of Japanese mathematics is presented in most attractive garb. The paper, the type and the illustrations make of it a work which it is a delight to handle, but an American must feel some regret that this beautiful book with the imprint of an American publishing house is nevertheless from the press of a German printer, W. Drugulin, Leipzig.

The Japanese mathematics is largely indigenous and, as the authors well state, it is "like her art, exquisite rather than grand." Of the six periods into which the history of their mathematics may be divided the first extends to 552 A.D., and is almost entirely a native development. The second period, from 552 to 1600, was characterized by the predominance of Chinese mathematics. The third period was a kind of renaissance which reached its highest development in Seki Kowa (1642–1708), the most famous Japanese mathematician. The fourth and fifth periods, from 1675 to 1775 and from 1775 to 1868, are marked by the development of the *wasan,* or native mathematics. Even before these periods the Jesuits had secured a foothold in China, and a Japanese student of mathematics was working under Van Schooten in Leyden as early as 1661, so that some influence of European mathematics may be confidently assumed. The sixth period is the period of the present day which, in mathematics, at least, knows nothing of political and racial boundaries.

The uncertainty of the first and second periods is best illustrated by the fact that but 17 pages are devoted to their consideration. A passage in the discussion of the Chinese "Arithmetical Rules in Nine Sections" is also significant: "If these problems were in the original text, and that text has the antiquity usually assigned to it, concerning neither of which we are at all certain, then they contain the oldest known quadratic equation."

Tangible arithmetic seems to have secured its greatest development among the Japanese. The fundamental operations with the *soroban,* a modification of the Chinese *swan-pan,* are explained in a detailed manner, and illustrated with excellent photographs. Certainly it is striking that in Chinese *swan-pan* has the meaning "reckoning table," which corresponds precisely to the Greek word from which "abacus" is derived, this also having the meaning "table," particularly for bankers. The *sangi,* or computing rods, are explained both as used for representing numbers and also as applied to the solution of algebraic equations.

Extensive numerical computation appealed greatly to the Japanese as well as to the Chinese mathematician. The game side of mathematics is represented by magic squares, and even magic circles. An approach to the meth-

ods of the calculus is found in the *yenri*, or circle principle, which tradition states was devised by Seki Kowa.

This work should appeal to a wide circle of readers, to the students of the history of science, to all interested in Japanese civilization and even to the general reader, for much of the work is non-technical. Certainly this book will contribute to a juster and broader appreciation of the Japanese genius.

Louis C. Karpinski
University of Michigan

The Development of Mathematics in China and Japan; Abhandlungen zur Geschichte der mathematischen Wissenschaften, Vol. XXX. By Yoshio Mikami. Teubner, Leipzig, 1913. G. E. Stechert and Co., New York. Pp. x + 347.

The activity of Mr. Mikami in making the mathematics of China and Japan known to the western world is highly to be commended. Besides many articles dealing with particular problems of the history of mathematics, Mr. Mikami has an earlier work, "Mathematical Papers from the Far East," in the same series as this volume under discussion, and also another book jointly with Professor David Eugene Smith, "A History of Japanese Mathematics," published by The Open Court Publishing Company. The more active cooperation of some English-speaking historian of mathematics would have been desirable in the two volumes which were published in Germany. Professor G. B. Halsted has, indeed, prefatory notes in the volumes which imply that the task of correcting the English was entrusted to him, but the literary charm of Professor Halsted's own works is lacking here, and even unintelligible as well as non-idiomatic English mars the excellence of these works. Errors are too numerous to be listed.

The book is divided into two parts: the first 21 chapters discuss the Chinese mathematics, and the following 26 chapters the Japanese. Three chapters which are of great value to the student of the history of science are entitled, A General View of the Japanese Mathematics, A Chronology of the Japanese Mathematics, and A Short Notice of the Historical Studies of the Japanese Mathematics. Somewhat similar treatment of the Chinese portion would have added much to the value of the work. An omission in the bibliography of the historical works is Souciet (Père), *Observations mathématiques, astronomiques, etc., tirées des anciens livres Chinois, ou faites nouvellement aux Indes et a la Chine par les pères de la Comp. de Jesus* (Paris, 1729), to which my attention has been called by Professor W. W. Beman.

Considerable uncertainty attaches to the dating, and even the content, of the ancient Chinese and Japanese mathematical treatises, but this, we may say, seems somewhat characteristic of our knowledge of the early Orient, particularly India. An evidence of this uncertainty is the fact that Mikami's description of the early "Arithmetic in Nine Sections" is quite different (footnote, p. 10) from that given by T. Hayashi in his "Brief History of Japanese Mathematics" which appeared in the *Nieuw Archief,* Tweede Reeks, Deel VI. (not accessible to me).

To the student of mathematics the most striking feature of this history will doubtless be the processes of solution of equations of higher degree than the second, by means of the *sangis* or calculating pieces. These solutions require a great amount of detail and approach closely the methods of Horner and Newton. The attention paid to the "squaring of the circle" is of interest, and the approach to a determinant notation is truly striking. The student of the history of mathematics will doubtless be most impressed by the description of the early Chinese process of multiplication of an integer of several places by an integer of the same kind, for the process corresponds in many details to the methods taught in the early works on the Hindu art of reckoning.

Some allowance for the enthusiasm of a Japanese writer must be made by the reader. However, to compare the Japanese Seki with Newton, "If Seki did not surpass Newton in his achievements, yet he was no inferior of the two," is quite beyond the bounds of allowable enthusiasm, for no evidence is presented

which in the least warrants this surprising statement.

In the present state of European civilization we turn with more interest possibly than formerly to these ancient civilizations of the East. English people can only regret that when the Japanese have taken the pains to write in the English language treatises of this kind about their history that even then the publication should be effected in Germany and Holland. Surely the people of the Orient should be met by English and Americans more cordially in scholarly as well as commercial matters. Mr. Mikami has rendered a real service to the history of science by this exposition of the development of mathematics in China and Japan.

Louis C. Karpinski

University of Michigan

Birds of New York. By Elon Howard Eaton. Memoir 12, New York State Museum, John M. Clarke, Director. Part 2. Introductory Chapters; Land Birds. Albany, University of the State of New York. 1914. 4to. Pp. 719. Sixty-four colored plates, and many half-tone illustrations in the text.

In the review of Part I.[1] it was said that "Of the many manuals and reports on birds issued under authority of the various state governments none approaches in voluminous detail and fullness of illustration the present work on the 'Birds of New York,'" of which Part I., comprising the water birds and game birds, appeared in 1910. It was further stated that "the author, Elon Howard Eaton, has shown himself well fitted for the task, both the introductory matter and the systematic part giving evidence of thorough research and good judgment." This high praise is equally merited by Part II., comprising introductory chapters on bird ecology (pp. 5–46), the economic value of birds (pp. 46–51), the status of our bird laws (pp. 51–52), special measures for increasing bird life (pp. 52–58), bird refuges (pp. 58–59), private preserves (pp. 58–60), and a systematic account of the land birds (pp. 61–543).

[1] Science, N. S., Vol. XXXII., No. 866, pp. 247–48, August 19, 1910.

The chapter on bird ecology treats (1) of the fundamental factors of environment, as climatic, physiographic, character of soil, and biotic; (2) bird habits; (3) nesting sites of New York birds, in respect to whether in banks, on the ground, in tussocks, in thickets, at different elevations in trees, or in structures erected by man, including bird boxes specially provided by man; (4) bird communities, classified with reference to breeding haunts; (5) succession of bird life, with reference to climatic and edaphic conditions; (6) the influence of culture conditions, as timber cutting, draining of swamps and marshes, pruning of shade and fruit trees, and effects of agriculture; (7) birds in relation to their food habits; (8) injury done by birds, in different ways by particular species; (9) economic value of birds, as destroyers of insects, weed seeds, field mice, etc.; and, finally (10) measures for increasing bird life, as the erection of artificial nesting sites, and the planting of trees and shrubs that yield them shelter or food.

The systematic part treats of the genera and species in the sequence of the A. O. U. Check-list, from the vultures to the bluebird, in the detailed manner indicated in the review of Part I. The 65 half-tone illustrations in the text are mostly of young birds or of nests and eggs, but include a few full-length views of birds from mounted specimens; the 64 colored plates are by Fuertes, and thus scarcely need further comment, except to say that the color-printing is of very unequal merit, being for the most part good, but far from satisfactory in many of the sparrow plates and in some others, which, of course, is not the fault of the artist. The subject-matter does great credit to the author and to the state, and the work will always be the standard authority on the ornithology of New York as known at the time of its publication. As a piece of book-making it falls far short of being a model. There is no table of contents beyond the chapter titles given on the title-pages, nor any list of the text illustrations, nor of the plates; the index is placed after the plates with a hiatus in the pagination

from page 543 to page 673, presumably to cover the explanatory leaves facing the plates.

J. A. Allen

American Museum of Natural History,
New York

Nature and Development of Plants. By Carlton C. Curtis, Professor of Botany in Columbia University. Illustrated. New York, Henry Holt & Company. 1914. Pp. vii + 506.

A few years ago it fell to the reviewer's lot to discuss in these columns the first edition of this excellent text, and it is with pleasure that he offers herewith his comments on its recent revision.

It is well that a book of this kind has met with that degree of appreciation and success which has warranted its third edition in so short a time. It is rare among our text-books of botany that the essential facts of the science are presented in a style at once so clear and attractive as to hold the attention of the casual reader, to say nothing of its acceptability to students. Too often is it the tendency among writers to kill, in the average student, all interest in a subject naturally engaging, by a dictionary style of composition and a pedantic devotion to technical terminology. Technical terms are well enough in their place, but their acquisition is not the end of botanical study, and to present the nature and development of plants accurately and in simple language demands a keener appreciation of the facts and their relations, than it may require to clothe the subject in the diction of a specialist.

One of the points in which this book is especially to be commended is the effort of its author to direct attention to the economic bearings of the subject. While the deeper thinker has no difficulty in appreciating the practical value of pure science, so-called, the fact remains that most students are stimulated by a perception of the relation of this or that fact to human welfare, and the more the facts of such relation are emphasized, the less will botany have to contend for its just place in the academic program.

It is the aim of the author, as stated in the preface, that the mastery of this text shall exact strenuous effort on the part of the student, an excellent motive from the pedagogical standpoint, but an end which is better reached in the laboratory than elsewhere. Such a purpose would hardly be achieved in the present volume with its clear and simple style, unless it be in the mass and suggestiveness of its fact, which we take to be the author's intent.

The book before us is divided into two parts. The first deals with the plant as an organism, definite, vital, dynamic. In this the topics of photosynthesis, transpiration, absorption, growth, reproduction, etc., as well as the structure of the tissues concerned, are treated with special reference to the seed plant and introduces the significance of plant structures and life. Part two presents the subkingdoms of the plant world and their more common representatives, setting forth the principal features of relationship and evolution. The book should form the basis of a year's study, supplemented by lectures and laboratory work. The illustrations are excellent and well chosen.

J. E. Kirkwood

Missoula, Mont.

BOTANICAL NOTES

THE ANNIVERSARY OF A GREAT GARDEN

Several months ago the botanists of the world were asked to come to St. Louis about the middle of October to celebrate the twenty-fifth anniversary of the organization of the board of trustees of the Missouri Botanical Garden. And in planning the celebration those in charge wisely provided for a dignified program of scientific papers of notable merit, rather than for a series of congratulatory addresses. Of course there were some congratulations, but these were confined to the after-dinner speeches, at the close of the anniversary exercises. So there was a minimum of inane congratulations, and a maximum of notably meritorious botanical papers. The example of the managers of this program is commended to other managers of anniversary exercises.

Here it should be remembered that Henry

Shaw was born in England in 1800, and that coming to America he amassed a fortune by middle life, and retired from business, spending the remainder of his life in beautifying his estate in the suburbs of St. Louis. Eventually this became known as "Shaw's Garden." About 1860 it was opened to the public, and in 1889 was transferred to a board of trustees to administer the estate under the provisions of Mr. Shaw's will, as the Missouri Botanical Garden. The garden has thus no legal connection with the city of St. Louis and it even pays taxes on all of its real estate excepting only the land actually occupied by the garden itself. The garden has been fortunate in its immediate management, which is vested in its director. The first director was Professor William Trelease, who filled this position with distinguished honor until his resignation in 1912, and he was followed by Doctor George T. Moore, whose two years of service have already proved his fitness.

The general program as announced in SCIENCE for September 11, 1914, was carried out with some additions and changes due to the disturbances caused by the European war. The mornings were spent in visiting places of interest in the city, and at the garden. The midday lunches afforded excellent opportunities for extending personal acquaintances. The program of the first afternoon (October 15) included after Director Moore's address of welcome (mainly historical), eight papers, six of which were actually presented, the remaining two being read by title only. Thus the papers by Director Britton (New York), Professor Wille (Norway), Professor Bessey (Nebraska), Professor Conzatti (Mexico), Professor Coulter (Chicago), and Assistant Director Hill (Kew) were presented in full, while those by Doctor Lipsky (Russia), and Director Briquet (Geneva) were not in hand, and were presented by title only.

The program of the second afternoon (October 16) included ten papers, of which those by Professor Czapek (Prag), Director MacDougal (Desert Laboratory), Doctor Appel (Berlin), Professor Setchell (California), Director Westerdijk (Amsterdam), Professor Atkinson (Cornell), and Doctor Smith (Washington) were presented in full, while those by Director Fitting (Bonn), Director Klebs (Heidelberg), and Professor Buller (Manitoba) were presented by title only.

The closing banquet was worthy of the occasion. Those who have been fortunate enough to be bidden to the "Shaw Banquets" need no description as to what this one was like. It was notable for the profusion of floral decorations, public report asserting that more than six thousand plants were used for this purpose, including about six hundred varieties of decorative plants. In a second matter this banquet was notable in that for the first time there were women among the guests, as should be, of course, when we remember the very considerable number of women who are engaged in botanical investigation, and in botanical teaching.

TRICARPELLARY AND TETRACARPELLARY ASH FRUITS

FOR several years I have been watching some of the green ash trees (*Fraxinus pennsylvanica*) along the streets of Lincoln, having found many years ago that some of them were in the habit of producing tricarpellary fruits, in addition to their usual bicarpellary samaras. As a result, several months ago I found one tree that produced these fruits in such numbers that the case seems to me to be worthy of record. One of my assistants, Mr. F. F. Weinard, collected from this tree 87 clusters of the fruits, and found that the average number of fruits in each cluster was 25, of which on an average ten were tricarpellary. In other words of the whole number of samaras examined (2,183) there were 876 that were tricarpellary. This means that almost exactly 40 per cent. of the whole number of fruits were tricarpellary, a proportion that is quite unlooked for. In the same collection there were found four tetracarpellary fruits, that is about one fifth of one per cent.

Elsewhere in the city other trees were found that produced tricarpellary fruits, but it is a well established fact that most green ash trees produce very few, if any, of these abnormal fruits.

STAMENS AND OVULES OF CARNEGIEA GIGANTEA

Through the courtesy of Director MacDougal of the Desert Botanical Laboratory at Tucson, Arizona, a lateral branch of the giant cactus (*Carnegiea gigantea*), measuring about a meter in height and twenty centimeters in diameter has been blossoming at intervals since May in the botanical plant houses of the University of Nebraska. No less than five distinct sets of flowers have appeared in this time.

From the first the number of stamens interested us, and some estimates were made of their number, but these varied so much that at last it was determined that the only thing to do was to make an accurate count of the stamens. Accordingly Mr. R. E. Jeffs, a fellow in botany, was asked to determine the number by enumerating every stamen, not making any *estimate* whatever. The result was astonishing, for it was found that there were 3,482 stamens in the flower, probably the largest number recorded for any flower.

This quite naturally raised the question of the number of ovules in the same flower, and Mr. Jeffs accommodatingly counted these also, with the result that he found 1,980 ovules. Here again the number is unexpectedly large, but the result is by no means as astonishing as in regard to the stamens. These figures are deemed worthy of publication.

Charles E. Bessey

The University of Nebraska

SPECIAL ARTICLES

ACTIVATION OF THE UNFERTILIZED EGG BY ULTRA-VIOLET RAYS

The sterilizing effect of the ultraviolet rays suggested the possibility that with their aid unfertilized eggs could be induced to develop, since the writer's previous experiments have shown that any substance which acts as a cytolytic agency can also produce artificial parthenogenesis. It was found, indeed, that the unfertilized eggs of the sea urchin *Arbacia*, as well as those of the annelid *Chætopterus*, can be caused to develop by a short treatment with the Heraeus quartz mercury arc lamp. The lamp was fed with a current of 3.4 amperes, the voltage of which was 220. The alleged candle power of this light was 3,000. The eggs were at the bottom of a glass dish covered by a layer of 2 cm. of sea water. The dish was open on top and it stood directly under the lamp at a distance of 15 cm. In order to prevent the temperature of the eggs from rising above the normal room temperature the glass vessel containing the eggs was surrounded by melting ice. The eggs formed a single layer on the bottom of the dish, since it seemed that the eggs lying on top screened the eggs under them from the effect of the ultraviolet light.

When unfertilized eggs of *Arbacia* were exposed to the ultraviolet light for ten minutes, many and sometimes all formed fertilization membranes. In some of the eggs this membrane was only the fine gelatinous film which the writer called an atypical membrane; others possessed a typical normal fertilization membrane. When nothing further was done with the eggs they underwent, at room temperature, cytolysis without segmentation. When the temperature was below room temperature (about 12° C.) some of the eggs segmented into two or four cells, but then perished. When the eggs were put for twenty minutes into hypertonic sea water, about ten minutes after the treatment with ultraviolet light, they developed into larvæ. The eggs had suffered, however, since few developed beyond the gastrula stage. When the eggs were exposed too long to the ultraviolet light (*e. g.*, twenty minutes) they formed fertilization membranes, but were injured to such an extent that they could no longer segment or develop.

It was of interest that a cover glass of 0.1 mm. thickness prevented all effects of ultraviolet light even if the eggs were exposed forty or sixty minutes. Such eggs remained normal. A layer of from 2 to 6 cm. of sea water did not prevent the effect of the ultraviolet rays. Neither did the rather thick walls of a quartz test tube.

The membrane formation by ultraviolet rays took place in the absence as well as in the presence of oxygen. When unfertilized eggs were put into quartz test tubes from which all the oxygen had been driven out by sending a powerful current of hydrogen through for four

hours, the ultraviolet light still caused membrane formation. This effect of the ultraviolet rays was not prevented by even an excessive quantity of NaCN, which inhibits oxidation in the egg. The membrane formation under the influence of ultraviolet light took place in neutral solutions as well as in weakly alkaline ones.

The calling forth of the membrane formation was due to a direct action of the ultraviolet rays upon the egg and not to a product formed by the rays in the sea water or in the air. For sea water which had been exposed to the influence of the rays, no matter how long, without containing eggs, did not cause membrane formation when the eggs were put into it after the ultraviolet light was turned off.

These experiments show that causation of membrane formation in the unfertilized sea urchin egg and the subsequent inducement to development were due to the direct effect upon the egg of ultraviolet waves below 2607 Å. u., since, according to Dr. and Madame V. Henri, waves below this range can not penetrate a cover glass of 0.14 mm. thickness. It is not possible to state in which way the ultraviolet waves caused the membrane formation in the egg except that it could take place without free oxygen as well as in the presence of NaCN.

The results mentioned thus far were obtained in the egg of the sea urchin. The egg of *Chætopterus*, after an exposure of from five to ten minutes to the ultraviolet rays under the conditions mentioned above, developed into swimming larvæ, without cell division.

Since Röntgen rays are only very short light waves, and since they also cause cytolysis, they should also cause membrane formation of the unfertilized egg. It is of interest that G. Bohn states that Röntgen rays induce artificial parthenogenesis. His experiments were made before the rôle of the membrane formation (or the alteration of the surface of the egg) was recognized as a necessary step in development, and he therefore does not mention whether or not Röntgen rays induce membrane formation.

JACQUES LOEB
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ON THE FEASIBILITY OF DETERMINING EXPERIMENTALLY THE LUNAR AND SOLAR DEFLECTION OF THE VERTICAL BY MEANS OF TWO CONNECTED WATER TANKS

FOR some time I have had in mind the essentials of the arrangement or apparatus described below, the purpose of which is to ascertain the deflection of the vertical as disturbed from its mean position by the attraction of the moon and sun. It may not be new; but I have never seen it described or referred to elsewhere.

Briefly described, such apparatus would consist of two tanks or cisterns of equal diameters and of equal depths, located some distance apart, upon the same level, and connected by means of a pipe. This pipe should be of metal excepting for some distance near its central portion where a glass section or length of much smaller diameter should be inserted. The pipe should be attached to the bottoms of the tanks in order to avoid complications which would otherwise arise should the temperatures of the water in the two tanks become somewhat unequal. But if the pipes are attached to the bottoms of the tanks, the unequal expansion of the water will not seriously affect the equilibrium and so will not set up any flow of consequence from one tank to the other.

At any given place upon the earth's surface the direction of the instantaneous vertical continually deviates from its mean position by a small angle dependent upon the time (or local hour angle) selected and the positions of the moon and sun relative to the earth's center.

Ignoring the attraction of the disturbed oceans, the plumbline upon an unyielding earth deviates in accordance with the impressed horizontal forces. These forces, in terms of g or terrestrial gravity are:

Eastward force,

$$
\begin{aligned}
= & -0.0000001684 \cos\lambda[\mathrm{M}_2 \sin(\mathrm{m}_2 t + \arg_0 \mathrm{M}_2) \\
& \qquad + \mathrm{S}_2 \sin(\mathrm{s}_2 t + \arg_0 \mathrm{S}_2) + \cdots]. \\
& -0.0000001684 \sin\lambda[\mathrm{K}_1 \sin(\mathrm{k}_1 t + \arg_0 \mathrm{K}_1) \\
& \qquad + \mathrm{O}_1 \sin(\mathrm{o}_1 t + \arg_0 \mathrm{O}_1) \\
& \qquad \mathrm{P}_1 \sin(\mathrm{p}_1 t + \arg_0 \mathrm{P}_1) + \cdots].
\end{aligned}
$$

Southward force,

$$
\begin{aligned}
= & \, 0.0000001684 \cos\lambda \sin\lambda[\mathrm{M}_2 \cos(\mathrm{m}_2 t + \arg_0 \mathrm{M}_2) \\
& \qquad + \mathrm{S}_2 \cos(\mathrm{s}_2 t + \arg_0 \mathrm{S}_2) + \cdots].
\end{aligned}
$$

$$- 0.0000001684 \cos 2\lambda [K_1 \cos (k_1 t + \arg_0 K_1) + O_1 \cos (o_1 t + \arg_0 O_1) + P_1 \cos (p_1 t + \arg_0 P_1) + \cdots].$$

Here M_2, S_2, K_1, O_1, P_1, denote abstract numbers or coefficients of tidal constituents bearing these names and are equal to 0.4543, 0.2114, 0.2652, 0.1886 and 0.0878, respectively. The angles in the parentheses are the arguments of the forces which give rise to the various constituent tides. λ denotes the latitude of the place or station selected.

The above expressions also denote the instantaneous deviation of the vertical expressed in radians (1 radian $= 206265''$).

Let L denote the horizontal distance between the centers of the two tanks. Let d denote the inside diameter of the small transparent pipe used and l its length. Let Ω denote the area of the water surface in either tank.

For convenience, consider here only the principal periodic term of the lunar semidiurnal tide and let the two tanks be situated upon the earth's equator. The foregoing expressions will enable one to make similar computations for all terms given, for any latitude, and for any orientation of the apparatus.

At a time three lunar hours before the upper or lower culmination of the mean moon, the surface of the water in the eastern tank will be $L \times 0.0000001684 \times 0.4543 = 0.0000000765\, L$ units higher than the surface of the water in the western tank. The reverse will be the case three lunar hours after either meridian passage.

The amount of water passing through any cross section of the connecting pipe will be

$$\Omega L \times 0.0000000765$$

cubic units.

If $2b$ denote the entire distance over which the water in the glass section of the pipe moves, we must have

$$2b \frac{d^2}{4} \pi = \Omega L \times 0.0000000765;$$

$$\therefore 2b = L \times 0.0000000765 \times \frac{\text{area tank}}{\text{cross section small pipe}}.$$

If this ratio be 10,000, then

$$2b = 0.000765\ L$$

units, and if the length of L be 10,000 units (say centimeters) then

$$2b = 7.65 \text{ units (centimeters)}.$$

Now the time required in making this transfer of water is 6 lunar hours, or 22,357 seconds; $\therefore$ the average velocity in the small tube will be $2b \div 22{,}357 = 0.00034$ units per second, and, because the disturbing force here used is harmonic, the maximum velocity will be $2b \div 14{,}233 = 0.00054$ units per second, and the maximum flux, $0.00054 \frac{\pi}{4} d^2$ cubic units per second.

This small velocity in a pipe say 1 cm. in diameter implies stream-line motion; and so we can compute by Poiseuille's laws the flux, or rate of discharge, under given or assumed conditions as regards the diameter and length of pipe and the difference of pressure at the two ends of this pipe. The formula for this is

$$\text{Flux} = \frac{\pi}{8\mu} \left(\frac{d}{2}\right)^4 \frac{p_1 - p_2}{l}$$

cubic centimeters per second. In the first place, assume that

$$p_1 - p_2 = L \times 0.0000000765\ g\rho.$$

Here ρ denotes the density of the water and is about unity;

$$\mu = \frac{0.0178}{1 + 0.337\theta + 0.000221\theta^2}$$

θ denoting the temperature Centigrade; and $g = 981$ centimeters per second.

If $l = 100$ cm., and $L = 10{,}000$, the flux, ignoring the resistance in the larger pipe, would amount to

$$\frac{\pi}{8\mu} \frac{1}{16} \frac{0.000765}{100} g$$

cubic centimeters per second, a quantity many times greater than the maximum flux necessitated by the water transference.

For a pipe 100 meters long and of diameter $\sqrt{10}$ centimeters, the flux will be the same as for the small pipe one meter long just considered.

From the above it can be seen that the effect of all pipe resistance can be so reduced by varying the diameters and lengths as to

not seriously interfere with the quantity of water actually transferred; and a little consideration will show that the amount of such interference can be calculated with some certainty.

Nothing has been said as to the nature of a float suitable for indicating the motion in the glass pipe. Somewhat as Forel in his "plemyrameter" used corks weighted to the specific gravity of water, so here a cylinder having a diameter somewhat less than the inside diameter of the glass pipe, and having the specific gravity of water, could be used. Each of the metal ends of such cylinder should be pierced by a hole, so that the cylinder could be threaded loosely on a fine wire stretched along the axis of the small pipe. However, some other style of float may be preferable to this. The readings should be made at regular hourly or half-hour intervals.

The amount whereby the observed *b*, properly corrected for pipe resistance, may fall short of its simple theoretical value, *i. e.*, its value on a perfectly rigid earth devoid of oceans, is an important factor in the determination of the amount of yielding of the earth to the known tidal forces, and so in the determination of the earth's rigidity. The interpretation of such measurements, however, constitutes no part of the present communication.

R. A. Harris

Washington, D. C.,
March 28, 1914

[Since the above was written, I have seen the surprisingly consistent results obtained by Professor Michelson and published in the *Journal of Geology* and in the *Astrophysical Journal* for March, 1914; also the account published in Science for June 26, 1914. It will be recalled that in these determinations, the vertical oscillation of the water's surface at the two ends of a half-filled horizontal pipe was the quantity measured. R. A. H., September 29.]

APPROXIMATE MEASUREMENT OF TEXTILE FIBERS

This note is hardly the place for the demonstration of the following theorem. However, it is readily capable of demonstration, and the reader of a mathematical turn of mind will at once perceive the line of proof.

Theorem. If an infinite series consisting of straight parallel linear elements of every possible length, each element arranged perpendicularly to and symmetrically to a given straight line, be bisected along that line and the two half-series thus produced be placed with the former outer edges of adjacent, then if the elements of one of the half-series be systematically rearranged, its longest element matched to the shortest of the other half-series and its next longest to the next shortest of the other half-series and so on, a new parallel-sided uniform series will be produced, each of whose elements has a length equal to the mean length of the elements of the original series.

If the theorem be changed so that the elements are stated to vary in length within prescribed limits, then for this modified theorem the line of demonstration as well as the final result is the same.

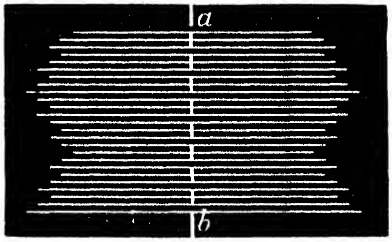

Fig. 1. Straight elements varying in length within prescribed limits, arranged symmetrically with reference to a given straight line, *a–b*, in accordance with theorem.

If the number of elements is limited, say, for example, to a few thousand, the result becomes approximate; and if the elements instead of having their middle points on the given straight line are arranged so that their middle points fall at random on either side of the given straight line a distance less than half the length of the shortest element, then the reconstructed series will have a width approximately equal to the mean length of the original elements; for it will always be pos-

sible to pair the elements whose middle points fall to the right with those whose middle points fall to the left in such a way, the long with the short, as to secure the result stated in

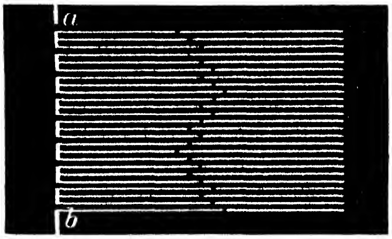

FIG. 2. Series shown in Fig. 1 bisected, and its left half transposed and turned over. For the sake of simplicity, in Fig. 1 the elements are so assorted that in Fig. 2 they match without rearrangement. The width of the second series (Fig. 2) equals the mean length of the original elements.

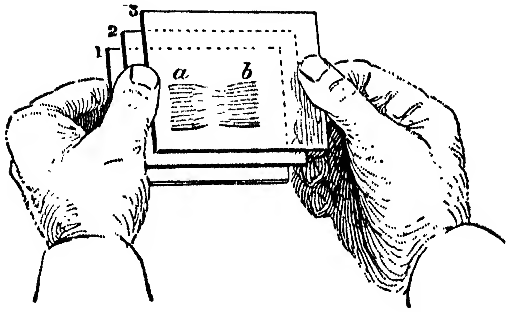

FIG. 3. Application of the theorems to the measurement of textile fibers in mass, for instance a "pull" of cotton fibers. The pull consisting of about 2,000 fibers is cut in two transversely with clean sharp shears. One half of the pull "a," is placed between thin glass plates, 1 and 2 (lantern plate covers). The other half is placed between the glass plates 2 and 3. 1 and 2 are pressed firmly together with the left hand, as shown, while 3 is held loosely with only its left hand edge in contact with 2 and resting against the left thumb, its right hand edge being lifted so as to enable the operator to move the fibers "b" back and forth over the fibers "a" by friction. Or the fibers "b" may be moved back and forth in any one of several different ways. For instance, the left edge of "3" may be used to move "b" back and forth on "2." When "a" and "b" are adjusted the three plates of glass are held in the left hand and the measuring scale applied with the right hand.

the theorem approximately, the degree of approximation depending on the number of the original elements and the uniformity of their increments in length when arranged in the order of their magnitude.

It has been ascertained by comparison with the results of my accurate method of measuring the length of fine crooked fibers, a description of which has already been published, that if a series of textile fibers be arranged in a manner similar to that described in the theorems, the mean length of the fibers can be measured approximately, if proper allowance be made for the "fly-back," or shortening of the fibers, due to their elasticity.

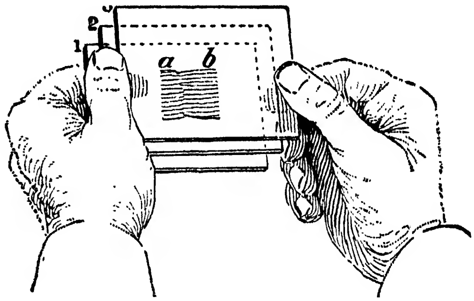

FIG. 4. The halves of the "pull" shown in Fig. 3 matched ready for measurement. The halves are adjusted against a strong transmitted light and yet with a good top-light; for instance, against sky-light reflected from a mirror laid on a table near a window; "b" is so adjusted over "a" that the fiber masses present the same shade from end to end. This simple optical method is found to approximate the conditions of the theorems. Care should be taken not to disturb the parallelism of the fibers. The width of the series, as arranged in Fig. 4, represents the mean length of the fibers minus the "fly-back." This latter, about one millimeter in twenty-five for well-conditioned cotton fibers, has to be added. The results are accurate to the fraction of a millimeter. The method is definite, readily learned, and easily applied.

It is intended to publish details in connection with this approximate method of measuring textile fibers in a separate publication.

N. A. COBB

BUREAU OF PLANT INDUSTRY,
DEPARTMENT OF AGRICULTURE,
September 25, 1914

SCIENCE

FRIDAY, NOVEMBER 13, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NATURE AND PURPOSE OF EDUCATION[1]

Students of Michigan: From farm, village and city, from every state in the union, from every continent in the world, you have come to spend here from four to six years in the formative period of your lives. Why are you here? What has impelled you to leave your homes and come to this small city? While Ann Arbor is a pleasant place in which to reside, there are many other cities, both larger and smaller, more attractively located. We have no inspiring view of ocean, no picturesque lake, no majestic river, no towering mountain peaks, no vine-clad hills, no broad valleys, no historic associations, no ruined castles. Ann Arbor is a commonplace town, pleasant enough in its way, but without the material attractions of which a hundred other places may boast. What is the loadstone that has drawn you from near and from afar? It is the university. What is the university, why does it exist and what is your purpose in coming to it? Some universities have been founded to perpetuate theological creeds, some to serve as monuments to men of wealth and power, but neither of these motives actuated the founders of this university. It had its inception in the wisdom of the early settlers of this state, it has been and is maintained by the labors of their descendants. The rich and the poor contribute to its support. Many of the former send their sons and daughters to more aristocratic institutions and many of the latter are not able to send their children to any university, but all pay in proportion to their means to the support of this institution. What justifies the people of this state in imposing upon themselves the burden of taxation necessary to sustain this university? The total fees paid by

[1] A popular lecture to the students of Michigan University on Convocation Day, October 16, 1914.

you each year would not carry the current expenses for three months. The people of the state are, therefore, giving each of you more than four times what it received from you. Each of you becomes a debtor to the state. What does the state demand from you in return for its generosity? There is an implied moral contract between each of you and the state, and unless you intend to comply with your obligation to the state you should not be here. The university does not exist in order to support the saloons and billiard halls of this town nor to afford a comfortable residence for loafers, and the university authorities are not worthy of the trust imposed upon them if students of this class are permitted to remain here. This is not a reformatory institution, nor is it an asylum for the feeble-minded, the state having made provision elsewhere for those wanting in morality and intellectuality. Admission is a privilege and continued residence should be permitted only to those who show intelligence, industry and integrity in all proper functions of student life. Even admonition to more earnest work or better behavior is not a duty of the university teacher to his students. The purpose of the university is to better fit you for citizenship. With this end in view, the people of Michigan expend on you more than one million dollars annually, a sum which if capitalized at four per cent. represents twenty-five millions. This means that the amount annually paid for the support of this university is equivalent to a contribution of more than one third of a dollar from every inhabitant of the state. Is this expenditure justified? Why should the state be so generous and what obligation do you assume in accepting this generosity? If there be among you those who do not feel any responsibility in this matter, in all honor let such depart immediately. The state does not educate you in order that you may make a living more easily. It does not intend to make shyster lawyers, who fleece their clients, nor quack doctors who rob the sick and afflicted, nor ignorant engineers who build unsafe bridges, nor indifferent school-teachers who perform their tasks perfunctorily, nor lazy farmers who impoverish the soil; but it does hope to educate jurists who will see that only wise laws are enacted and in their administration justice shall be done, physicians who will render the sick the best service and protect the well from disease, engineers who will develop the natural resources, school teachers who will train the young in body and mind, and farmers who will improve the fertility of the soil. The state realizes that intelligence, industry and integrity are the great factors in the betterment of the conditions of life and it seeks the development of these attributes in all its citizens. In a generous spirit it offers its training in these qualities to all who are capable of development along these lines whatever their nationality, color or creed may be. One who is lacking in any one of these cardinal virtues can not be of service to the state and should not seek his education in a state university. Without intelligence development is impossible; without industry life is barren; without integrity the individual is a menace to the state.

In a broad sense, education has been defined as the modification and development of behavior through experience. Since behavior is determined through the mechanism of the nervous system, education is concerned especially with the function of the nerves. Man comes into the world the most helpless of all animals. At birth the child is incapable of locomotion and of finding unaided its food supply. For months, and indeed for years, the child remains in this helpless state. The dog in the first six months of its life learns more than the child does in years. It is the superiority of his nervous mechanism that has given man dominion over the earth and all that is therein. We need sound bones, strong muscles and healthy organs, because these render the development of the nervous system possible, and the health of the body, as a whole, is essential to the well-developed man. We can have no correct conception of education without some knowledge of the mechanism employed in its acquisition. Briefly considered, the nervous system consists of receptors or special senses, which are stimulated by the

environment, of conductors which transmit the stimulation to the central organs and of effectors which control and direct the responses to the stimuli. The primary function of the nervous mechanism is to provide paths of conduction between the receptors and effectors. The first breath of air at birth starts the machinery of respiration. Irritability and automatism are properties of all living things. Even unicellular organisms, amebæ, for instance, in which there is no nervous tissue, automatically respond to external stimuli, such as food, and changes in behavior or rudimentary and limited education can be developed in them. As cell differentiation is evolved the structure of the nervous system becomes more complicated and its functions are more diversified and effective.

A sense receptor, such as the eye or ear, the sensory nerve, such as the optic or the auditory, the nervous center to which the impression is conveyed and the motor nerve, through which the response is transmitted, constitute the "reflex arc." Reflex action is the simplest function of the nervous system. Strong light induces contraction of the pupil, the sight or odor of food causes the saliva to flow, pinching the flesh is followed by muscular movement. These are examples of innate reflexes. The normal child comes into the world possessed of these reflexes. A large part of education consists in the coordination and development of these innate reflexes. Walking, talking, reading, writing, are examples of coordinated, trained reflexes.

The first lesson we learn in investigating the mechanism of education is that the sense receptors must be in good condition to start with and must be kept in the highest state of efficiency as we proceed. The receptors through which our behavior is modified and developed by environment are the five senses, seeing, hearing, touch, smell and taste, each of which, on close analysis, is found to be complex. All primary knowledge reaches the brain through these sources. In no other way can environment modify our behavior or can we be educated. The dictum of Locke, "Nihil in intellectu est quod non prius in sensu," is not refuted by the addendum of Leibnitz, "Nisi intellectus ipse." When the senses are defective in function, illusions, hallucinations and delusions control us and dominate our conduct. The senses may be primarily defective and to some extent these defects may be removed by medical skill. When normal in mechanism these functions may be impaired by poisons introduced from without the body, such as alcohol, or by those generated within the body, such as those due to fatigue or to disease. Although the truth expressed in the Latin proverb, "Mens sana in sano corpore," has come down to us from classical times, educators have been slow to realize its force. Indeed, when mystical scholasticism formulated educational ideals affliction of the body was believed to be essential to the highest development of the mind. Fortunately, even educators, one by one, with some reluctance, are awakening from their dreams and becoming interested in scientific investigation. Greater benefits in educational methods have been obtained by observation of the effects of altered environment on the behavior of animals than have been evolved from the inner consciousness of the greatest genius. Appreciating the fundamental importance of normality in securing an education, this university is developing a splendid system for the supervision of the health of its students. However, the health of each individual is largely in his own keeping, and I wish to say that idleness, alcoholism and sexual vice remain the most potent factors in student wreckage. With senses untrained from idleness and benumbed by dissipation, the individual is a failure in college and in the greater school of the world.

Certain complex reflexes are known as instincts. These play an important part in education. All instincts are not manifest at the time of birth, but develop with age and are influenced by the evolution of the individual, as a whole. The instinct of play manifests itself in every normal child and the same is true of the instincts of acquisitiveness, construction, possession, self-assertion, anger, self-abasement, rivalry, pugnacity, etc. These

need to be controlled and directed, and this constitutes an important part of education. They are inherited, but are subject to marked modification by environment. For instance, the instinct of imitation is one of great potency in shaping our conduct and in determining not only our own lives, but of those about us. In this lies sufficient justification of state education. One scientific farmer in a community enhances the value of all the farming land about him, because he demonstrates the productivity of the soil. One honest, learned lawyer reduces litigation and a skilful physician not only alleviates the suffering of the sick, but prevents the spread of disease. The highest purpose of this university is to train leaders of men, those whose influence among their fellows may always be in the right direction.

Success will depend largely upon the environment under which you live while here. This can not be wholly determined by the university authorities. To a large extent you will educate one another.

A part of education consists in inhibiting reflexes and suppressing misdirected instincts. The only way in which this can be done is by the cultivation and exercise of certain other reflexes. As we shall see later, nervous impulses travel most easily over well-worn pathways. A function frequently performed proceeds automatically and to the exclusion of antagonistic tendencies. One of the most difficult things the untrained student has to contend with is diffuse activity. He tries to study, but outside stimuli of vision, hearing, etc., bombard his sensorium and demand his attention. Training is essential before calls to purposeless activity can be ignored.

The first impression which one receives in studying the structure and function of the nervous system is that it is a grossly defective mechanism. The elements of which it is composed consist of nerve cells with axons and dendrites. The dendrites are supposed to receive the stimuli and the axons to conduct them to the next unit. Between these units, called neurones, there is no direct structural connection. The axons of one unit come in more or less direct contact with the dendrites of the next, but each neuron is organically quite distinct from all others. The apparent imperfection lies in this absence of direct connection. The point of contact between two neurons is known as a synapse and at this point there is more or less resistance to the transmission of the stimulus. This apparent imperfection is, however, in some respects at least, a benefit. Were it not for this delay the brain would be stormed continuously by stimuli from the outer world and orderly thought would be quite impossible. Without these apparent imperfections, sleep would be less restful and anesthetics would not be able to relieve pain. Education consists partly in improving these connections. A pathway through the nervous tissue having been once opened is more easily followed by subsequent similar stimuli. This renders possible the formation of habits. The more frequently a given pathway is traversed, the more easily stimuli pass, until finally transmission occurs without conscious effort. The first attempt to learn is more or less laborious, but with each repetition the resistance becomes less and finally the thing is done automatically. Effectiveness is largely the result of the formation of good habits. In this way the expert is developed. The best preparation for doing anything is the fact that you have once or oftener done it, and the more frequently it has been done the more certainty is there in repeating it. The beginner in telegraphy must give attention to each letter, then he thinks only of words, and later he advances to phrases and even to sentences.

In learning of this kind, progress is not always uniform. After reaching a certain degree of proficiency there is a period in which there is no apparent progress. These periods are known as plateaus. All students are familiar with these depressing states in which effort seems without avail, but with persistence the curve of learning suddenly begins to rise and the elation of success is the reward.

The question of the transference of skill acquired in one branch of learning to another has been debated among psychologists, but the

weight of evidence is that it is not possible. Being an expert mathematician does not make one an authority in law or medicine. The neural pathways opened up in the pursuit of different branches of learning are not the same. They may lie quite far apart and expertness in one line does not imply even soundness of judgment in another. This is an important matter in education and will receive further attention later.

The formation of habit is common to all animals, and habits have a marked influence on behavior. We do things so often that it becomes difficult to refrain from doing them when the conditions under which they have been done recur. The most forceful teacher of my college days was wont to say: "Man is but a bundle of habits and happy is the man whose habits are his friends." At twenty, it seemed to me that the force of this saying lay in its sonorous quality. At sixty I realize that its strength lies in its truth. The young scout the idea that they can not indulge in a vice occasionally without becoming a victim. The chains forged in the smithy of habit are strong in every link. They may safely hold us in the heaviest storm or they may drag us to the bottom of smooth seas. Another mistake often made by youth is the belief that every experience is helpful. There is no other commodity for which we pay so dearly and the price often is health, happiness and even life.

Some stimuli make such deep and lasting impressions on the central nervous system that the picture may be recalled without the recurrence of the original stimulus. This is memory. Jennings has shown that there is some evidence of memory even in unicellular organisms. This becomes more marked as the animal structures, especially the nervous system, develop. Even a spider learns by experience and alters its behavior to its own benefit, when repeatedly subjected to like conditions.

Colvin says:

> Memory is a fundamental phenomenon of organic life. In its widest sense it signifies the fact that impressions once received by an organism are retained for a greater or less period and that this retention is indicated in the modified behavior of the organism. The evidence of memory in animals is their ability to profit by experience. A white rat is placed at the entrance of a maze at the center of which is food. The animal moves about in an aimless manner until at length it reaches the center. If on succeeding trials the rat shows an improvement in the accuracy and rapidity with which it moves about the maze, this means that its earlier attempts have in some sense left their effects; they have modified subsequent conduct. Memory, when used in this widest sense of the term, lies at the basis of all learning. It is a measure of educability.

There are three important factors in memory. The impression must be "stamped in." It must be correctly associated with other impressions. It must be subject to recall and proper recognition. The strength of the impression is dependent upon many factors. The brain may be so altered by inherited defect, trauma, senility, fatigue, disease or toxic agents, that effective and lasting impressions can not be made. So long as the brain remains in the abnormal condition its receptivity can not be improved. The mentally defective can be educated to a certain point, but can go no farther. An impression may be "stamped in" by the force or unusual character of the external stimulus. The external world demands the attention of the individual and an unusual sight, noise or other sensation makes a never-to-be-forgotten impression. This is known as passive attention and is common to all animals. It is the basic principle in all attempts to modify behavior through hope of reward or fear of punishment and is highly effective in the control and training of the lower animals and ignorant men, but loses in power with the development of intellect. However, in this and other universities this appeal to increased effort is employed in the form of grades, admission to special societies, the bestowal of insignia of distinction, etc., and on most men in our stage of development it is not without effect. The approval of our fellows as shown by social, political and intellectual preferment, still proves a potent incentive to increased effort. With the development of intellect, passive attention is largely supplanted by the active form. In

the latter the individual selects the stimuli which are to make permanent impressions. An important function in the accomplishment of this purpose is the rejection of stimuli believed to be unimportant or harmful, and seizing upon and fixing of those recognized as of greatest value. In this selection lies the pathway to wisdom. It determines the ideals of the individual. It shapes the ego and sets the lines of future development. The memory pictures photographed in the highly labile molecules of the brain constitute a record of all our available knowledge, not only that gained through personal experience, but that acquired from any source. We rehear the spoken and reread the written word. We recall the facts of history. We utilize without conscious effort in our daily dealings the mathematical skill acquired in childhood. We make practical application of the scientific discoveries of the past in supplying ourselves with the necessities and comforts of life. We enjoy the literature of all nations in all ages. In short, the storehouses of learning to which we have access are practically limitless in their wealth, and from this we may select at will and appropriate to our own use without diminishing to the smallest degree what is left for others.

In order to be of greatest service, memory pictures must be clear and properly placed. Clearness and association are essential to prompt recall and correct recognition. Memory, like all other functions of the nervous mechanism, is capable of improvement by exercise. When memory pictures have a faulty setting, they may influence behavior disastrously. The old man thinks all this talk about impure milk killing infants and infected water causing typhoid fever is nonsense, because all his life people, both young and old, have been drinking dirty milk and polluted water. He does not know or recognize the fact that many even within his own circle have died from these causes. In his experience these facts have not been recognized as possessing any causal relationship. Half his children have died from the summer diarrheas of infancy and others have died in youth from typhoid, but he has always connected these bereavements with the world-old belief that disease could not be prevented nor death delayed. The failure to properly correlate experiences or their memory pictures is one of the things which prevent many elderly people, especially the untrained, from adjusting themselves to advances in knowledge. Many superstitious rites and ceremonies have their origin in the faulty conception of cause and effect. Many reason post hoc ergo propter hoc. This faulty logic is still a strong support of charlatanism in its many survival forms.

The study of the structure and function of the nervous mechanism makes plain what should be attempted in securing an education. We have seen that in the acquisition of knowledge pathways to the cerebral cortex must be opened up. Conduction of nervous impulses meets with resistance as it passes from one neuron to the next. This resistance grows less with each traverse of the impulse along the same path, and with frequent repetition the trail becomes so smooth that impulses pass through without conscious effort. It is easier to open up pathways to the cortex in youth than in later years because the lability and plasticity of the nervous tissue decrease with advancing age. However, lines of conduction established in the plastic period are never obliterated save by disease or death. Even with approaching senility, when the opening of new lines is impossible, those established in youth continue to operate. Truly, learning becomes the solace of age. The educated octogenarian remains in sympathy and intelligent touch with the outer world, while his untrained brother finds himself isolated and marooned on a small barren island. Furthermore, it has been demonstrated that the lines of conduction which serve in one department of learning are useless in the conduction of information from other sources. The acquisition of mathematical skill does not give special preparation for historical erudition. These elemental psychological facts indicate that in youth training of the nervous system should be broad, the purpose being to estab-

lish many and diversified sources for the supply of mental pabulum. Symmetrical exercise is as essential to the normal development of the nervous system as it is in muscular training. Athletes are not made by putting all muscles save one in plaster casts and exercising the free one, neither can the functions of the brain be properly developed in such a way.

What are the fundamental subjects which should form the basis of education? It goes without saying that the educated man must know his own language thoroughly. He should possess a large vocabulary and should select his words and shape his phrases and sentences with reference to smoothness of diction and clearness of statement.

Language is the medium of exchange in mental commerce and it must be on a gold basis. Fortunately in this country dialects are not sufficiently developed to interfere with intelligent transfer of information. However, we are known for our diversified richness in slang. Some of these expressions are highly illustrative of multum in parvo in speech, sound in sense, rich in humor and forceful in meaning. The function of the educated man in regard to these colloquialisms consists in the suppression of the atrocious ones and the regulation of others. Next to color, speech is most powerful in fixing dead lines across the paths of individual advancement and usefulness. A man who is constantly blundering in the use of his native language can not be long tolerated among the educated, whatever his virtues may be. In European countries, dialect is a potent factor in class distinction. I never fully appreciated this until I met with the following experience in southern Italy. On a drive I saw a beautiful villa, picturesquely situated, quite new and untenanted. On my return to the hotel I asked an intelligent appearing man concerning the villa. He became quite excited and in broken, but plainly intelligible English he made the following statement: "I was born a peasant in this community. I never spoke Italian and knew only the local dialect. At sixteen I went to New York. During the forty years of my residence in that city my highest ambition was to accumulate enough wealth to enable me to return to Italy and to participate in its affairs, concerning which I kept myself thoroughly posted. Four years ago I closed my business in New York and returned to this place. My dreams were now to be realized. With much pride I purchased land and built the villa you have seen. But the moment I attempted to move in economical, social or political matters, I found a dead line I could not cross. I did not speak Italian. I do not blame those who repulsed me. You would not have at your table an American who did not speak correct English. In New York I spoke only broken and incorrect English, but all said Mr. Blanco is Italian and we do not expect him to speak correct English. The villa can rot. I am going back to New York." Even in this country and in university circles I have known men who show lack of fundamental education by lapses in speech. Some years ago I was called one morning into the country where a German farmer asked me to lance a "bile" on his arm. On my return to town I saw a university instructor who told me that he had been vomiting "boil" all morning. A temporary colleague of mine, a man of much merit, frequently said: "I done it." Another said: "them there things." It is needless to add that these men found themselves out of place in a university faculty. There is one peculiarity about men of this kind; they are infuriated at the most delicate attempt of a friend to help them in their defects. Every educated man should speak and write correctly by habit.

The study of Greek and Latin is a great factor in the comprehension of other languages partly derived from these. Moreover, one who is limited in his reading to translations, whether the original be in ancient or modern speech, loses much of the force, beauty and spirit of the author. It is true that there are translations which equal and a few which improve the originals. As one who has made scientific work his special endeavor during the entire period of his adult life, the speaker believes that the student who has

never dug Greek roots nor pruned Latin stems has missed much in both pleasure and discipline. If a bit of personal experience be permitted, the speaker testifies that the first author to quicken the pyramidal cells of his cortex was Virgil, and to-day when recreation is sought the only book preferred to Virgil is Dryden's translation of the same.

While an educated man's linguistic ability may be limited to English, inability to read French and German handicaps him, delays acquaintance with important discoveries in various realms of knowledge, and limits his mental vision. To scientific workers a reading knowledge of French and German is quite essential. There are splendid nuggets of science and glittering gems of imagination encased in Italian, and sparkling jewels of humor encrusted in Spanish, but these, with many other languages, both ancient and modern, can hardly be placed in the list of educational essentials, however important they may be to the special student or for direct vocal intercourse. When philologists grow away from the false idea that centuries are necessary for the development of effective language and when nations recognize that there is no need of limiting verbal and written intercourse by political boundaries, man will use a world language, more perfect in structure, more forceful in expression and elegant in diction, than any now used. This time, like that of universal peace and good will, now seems a long way in the future.

Man needs figures as well as words. His sense perceptions are registered in numbers. They take various shapes. He perceives not only plain surfaces, but extension in geometrical forms. He needs figures in all his mental concepts. Some of the lower animals can count in small figures, while those of man are unlimited. He must establish units of measurement, linear, square and cubical. The external objects which stimulate his sense organs and photograph themselves on the sensitive plates of his brain vary in number, shape and size. Every educated man should know mathematics through plane trigonometry.

History is a record of the experiences of past generations and of these no man can afford to be ignorant. The child comes into the world without inherited knowledge and the individual can not depend upon his own narrow and limited experiences. The brute has this to direct and modify its behavior, and we have enough of the brute disposition left in us to make us slow to profit by the experiences of others. This is a marked defect in youth. The young man believes that he can take personal, economic and social risks in which thousands of others have fallen, without injury. He believes that he was born under a propitious star, trusts his luck and goes to ruin by the same path that others have traveled and that more will continue to travel. If this were true only of individuals, it would not be so bad, but it is equally true of nations or rather of those who control nations. Some man, laboring under the delusion that he is a chosen son of destiny, brings about some horrible catastrophe which results in death, sorrow and suffering to the present generation and places chains of bondage on the unborn.

I have defined education as the modification of behavior by experience, and a large part of this experience which is to determine our behavior should be learned from history. History in the wide sense in which I am now using the word includes the record of all human experience. It is national, communal and individual.

Fuller says:

> History maketh a young man to be old without either wrinkles or gray hair; privileging him with the experience of age, without either the infirmities or inconveniences thereof. Yea, it not only maketh things past present, but enableth one to make a rational conjecture of things to come. For this world affordeth no new accidents, but in the same sense when we call it a new moon, which is the old one in another shape; and yet no other than it hath been formerly. Old actions return again furbished over with some new and different circumstances.

Failure to profit by the experiences of the past leads to the most serious disasters that befall our race. Study history. Study it in college and out of college. Devote much of your energy to it in youth, find time for it in

your busiest years, and do not neglect it in age. For if it maketh the young old without infirmity, it keepeth before the old the pictures of the eternal youth of the race.

There has been some discussion among partisan educators about the relative merits of humanistic and scientific studies. The symmetrical and effective development of the nervous system demands both forms of exercise. The man who knows the classics and nothing more is blind and deaf to much which is of the highest interest to both himself and his fellows. The man whose knowledge is confined to some narrow domain of science is equally out of touch with much that is necessary to make life rich in either endeavor or accomplishment.

Without experimental science man would be to-day in his primitive state, or more likely he would have become exterminated long since in his unequal contest with the elements and the brute creation. Even in his most perfect physical development he is inferior to many of the lower animals in muscular strength, fleetness and range of sense recognition; but he is unique among animals in the development of the instinct of inquisitiveness. He wants to know, therefore, he experiments. He observes the effect of altered environment, and his interest in experimentation grows in scope and purpose. He ascertains that when certain definite relations are established, the results are constant. He slowly develops an appreciation of causal relationship. After countless generations of crude experimentation, careless observation and faulty generalization, he sees the necessity of greater exactitude in his experimentation. In this way, slowly and laboriously, the sciences have been evolved. With periods of barrenness of variable length, some of which have extended through many consecutive centuries, man has slowly progressed from his primitive state to his present condition. Scientists, the greatest benefactors of the race, have always been few in number, but their work has benefited many. In some ages the masses have been too ignorant to utilize the scientific knowledge possessed and enjoyed by their ancestors and have shown marked retrogression. The most potent causes of these lapses have been disease, war and famine. In no age, not even the present, has scientific training touched more than a small part of the generation.

Some primitive man learned that fire could be kindled by friction between pieces of wood or that a spark could be struck with flint. What benefit came from this simple discovery? It gave protection from the cold of winter and greatly extended the range of man's activities. The camp fire, now started when and where he willed, frightened away beasts of prey, served to cook his food and formed the nucleus of a primitive home. One day, ore being used as stones for the crude hearth, metal is found in the ashes and the flint age is passed and that of metal has come. Century after century passes; accidental discovery is replaced by systematic investigation, and the science of metallurgy with its multiple benefits is developed.

Primitive man crouched in terror when darkness enveloped the earth at noon day. He could see in this only the angry disapproval of an all-powerful God. The stars were supposed to control the destinies of individuals, communities and nations. The motions of the celestial bodies were observed, the heavens were charted and astrology became astronomy.

Primitive man fed upon such fruits, vegetables, nuts and berries as the soil gratuitously offered him, eked out with the uncertain product of the chase. Experience showed that the productivity of the soil would be greatly increased by tillage, and that certain animals could be domesticated easily and made to serve man in life and after death. Having the breeding and feeding of these animals under his direct control, he has learned to modify them to suit his purpose. From a common stock he has evolved the draft, race and trotting horse, each with many variations. From the wild grains he has produced many varieties of each cereal, while at the same time he has increased the yield more than a hundredfold. By irrigation and cultivation he has converted thousands of acres of barren

desert into fields of golden grain, dotted with orchards bearing luscious fruits. When the territory now within our national continental boundaries was occupied by savage man, it supported only a few thousands, now under the stimulus of scientific agriculture it feeds, shelters, clothes, supplies the necessities of life to all and untold luxuries to many of its ninety millions of inhabitants and sends abroad enough to feed other millions.

In the long ago, some man observed the magnifying effect of a natural lens. The lapidary labored through centuries in the perfection and proper adjustment of lenses. The result was the evolution of the compound microscope. In 1849 a village doctor on the Rhine studied the blood of animals sick with anthrax under his crude microscope and compared it with the blood of healthy animals. He discovered the bacillus of this disease. This work under the genius and diligence of Davaine, Pasteur, Koch and others demonstrated the causal relationship between microorganisms and disease. The science of preventive medicine has been developed, the average of human life has been lengthened by fifteen years within one century and the way has been made clear for a like prolongation within a like period, provided the masses of the people acquire sufficient intelligence to properly utilize the facts already known. The capacity of the individual for work, rational pleasure and intellectual growth has been multiplied. Pestilential regions have been converted into fit dwelling places for man and his dominion over antagonistic conditions and forces of nature has been extended. Disease, which hitherto has excluded man from the fairest portions of the earth, has exacted heavy toll in all climes, has wrecked the greatest civilizations of ancient times and has more than once threatened the race with extinction, is now largely under man's control.

The foregoing are only illustrations of what science has done in the improvement of our race. I know of no scientific discovery which has not aided in the betterment of mankind and still science is in its infancy. Its ultimate goal is the domination of the forces of nature and their utilization in the betterment of mankind.

The fundamental principles and facts of the physical, chemical and biological sciences must be included in the courses taken by every student who wishes a broad, symmetrical education, whatever his business or professional calling is to be. Moreover, training in these sciences should not be of the amateur kind, but should be sound and thorough and accompanied by laboratory observation and demonstration. It should supply a sound basis which will enable the student in after life to reach correct conclusions, when scientific judgments must influence his behavior. The failure of those in high places to appreciate the value of scientific equipment and procedure has proved to be a serious matter many times. The importance of this subject justifies the mention of specific instances. When the Spanish-American War began in 1898, Congress refused to make appropriation for scientific medical equipment. The graduates of West Point up to that time had no instruction in army sanitation. Not a regiment, either regular or volunteer, went into the field with the medical equipment necessary to recognize either malaria or typhoid fever. Regimental commanders paid no heed at first to the protests of medical officers as to the location and sanitation of camps. The result was nearly twenty thousand cases of typhoid with more deaths from disease than from the shots of the enemy. Still, the only golden chapter in the history of that war is that which records the discovery of the manner of transmission of yellow fever, the lifting of the curse of this disease from the "Pearl of the Antilles" and the subsequent construction of the Panama Canal, made possible by this discovery.

The officials of the state of California denied the existence of the plague in San Francisco in face of the fact that its presence had been demonstrated scientifically. The result was the infection of certain rodents throughout a large territory and the expenditure of lives, money and energy in its eradication.

Duluth placed the outlet of its sewers and the intake of its water supply in close prox-

imity and paid for its ignorance in an epidemic of typhoid. A list of cities which have made similar mistakes is too long to give; a list of those which have followed scientific teaching would be shorter.

As I have indicated, our inability to utilize the known facts of preventive medicine means that the aggregate of human life in our population of one hundred million will measure one billion five hundred million less in years than it would were we, in the mass, more intelligent. This is a trustworthy and conservative statement of the stupendous price that this generation is paying for the ignorance of the many and for the special activities of Christian Science, the league for medical freedom and other impedimenta to the progress of scientific sanitation, which so far have been potent enough to block much needed legislation. There are many men directing our local, state and national affairs, among them graduates of our greatest universities and best colleges, who are as ignorant of, consequently as indifferent to, these matters which so seriously affect our national life—present and future—as are the untaught hordes that crowd into our country like so many cattle, through the gates of Ellis Island.

The fatalities due to ignorance of science make big figures in the mortality tables. Whether the infant lives or not depends most largely upon the scientific knowledge of the one who feeds it, and many a mother, who would give her life to save her child, murders it through ignorance. Surely, ignorance of such scientific knowledge as is necessary to protect health and life is a crime, a moral, if not a statutory one.

Descartes said that the purpose of all education is to enable one to reach sound judgment. Daily most of us are compelled to reach some judgment founded on scientific knowledge and training, and yet many college graduates are lacking not only in the knowledge but in the capability of comprehending it when presented.

I have indicated the subjects which in my opinion are essential to a liberal education, and I wish to add something about methods of study. It is a fallacy to suppose that every man who takes a college course gets an education and that all who do not have this privilege fail to be educated. The best university with the most complete equipment and the most learned faculty can do no more than supply opportunities. An education is not secured without effort on the part of the student. Too many college students follow lines of least resistance, dissipating instead of concentrating their energies, fall into bad habits, and instead of being improved are harmed by college residence. This is shown by their subsequent behavior. Forty years have I been in this university as student and teacher, long enough to see many uncouth, unpromising lads develop into eminent jurists, skilful engineers, able physicians and surgeons and, in short, honoring alike themselves and their alma mater in widely diversified spheres of activity by their deeds, but to-day I recall many who have been cast as useless driftwood upon the shores of life's sea. Were I asked to name the rocks which have caused the greater part of this wreckage I would mention—first of all, those that lie about the alluring islands of idleness. Inherited defects are not common among university students. The fact that they have been directed wisely at the start is proof of this, but it requires personal strength of character and fixedness of purpose to hold to the course. Next, but far less in number, are the high reefs of active dissipation. Lighthouses show their location and warn the sailor of danger, but he thinks he can pass through the narrows, where so many, less skilful than he, have been wrecked; he takes the risk and goes on to the rocks.

I drop the simile of the sailor and the rocks and continue my illustrations. One finds that he needs a knowledge of French or German in order to secure the fullest information. He elects the subject for one semester, works indifferently and fails. He concludes that he has no aptitude for language and tries something in another line in like spirit and with like result. Some men spend their lives in trying to find out what they are good for and die good for nothing. In my basic statements

I have emphasized the fact that effort is necessary in order to open pathways to the cerebral cortex and that *educatio strenua* is the only genuine article.

While I have made an earnest plea for a broad, liberal, fundamental education in order that we may be in intelligent touch with the basic conditions that control and modify human behavior, there is like physiological reason for advising every student to build on this broad foundation his specialty. When you have reared your house with heavy rocks for the foundation, massive walls, bound together with steel beams, on this you can carry up as high as you please the tower which will afford you an outlook. Take one subject and know everything that is known about it and if possible know more than any one else. In other words, in addition to your general knowledge be a specialist. To your general knowledge add the skill of the expert. The physiological reasons for this advice must be evident to all who have followed my line of argument. Neural pathways become smoother the more frequent the travel over them. I recommend expert development for the following reasons: (1) Extension of the domain of knowledge is secured. (2) The pleasure known only to the discoverer comes to him who does work of this kind. (3) It is a rest and recreation to turn into the well-worn paths along which thought moves automatically.

It is not essential that the special study, which I recommend, should be in the line of one's vocation. It may lie quite apart from business or professional duties.

The history of intellectual progress is quite in accord with the teaching that a broad educational foundation with the addition of expert learning gives the best results. I will mention a few illustrations of the educational training of men who have advanced human knowledge. William Herschell was a music teacher and never saw a telescope until he was thirty-five. His hobby was to grind lenses and make perfect mirrors. With these he discovered worlds, systems and universes. His great reflectors caught up light which left its source two million years ago. Our solar system became a mere speck in the range of his vision. Burnham became an enthusiast in the study of double stars, of which he discovered a thousand while he was still a stenographer in a Chicago court. Hutton, physician, chemist and farmer, showed that the earth's crust is a stone book, made up of pages, chapters and volumes. William Smith, the English surveyor, without college training, demonstrated that the characters used in this great stone book are the fossils. Cuvier, an anatomist, was the first to read some of the chapters in the history of the building of the earth. Buckland, doctor of divinity, extended the reading. Perraudin, the chamois hunter, suggested glacial action in shaping the earth's crust. The fox-hunter, Murchison, with Sedgwick, named the volumes of the stone book in order of their issue. Priestley, the dissenting clergyman, discovered oxygen. The Quaker physician, Thomas Young, the real discoverer of the undulatory theory of light, published many of his papers anonymously for fear that the rumor that he was a scientific investigator would injure his practise. Furthermore, he devoted some of his spare time to deciphering Egyptian hieroglyphics. Lavoiser, the father of chemistry, went to the guillotine. The official while signing his death warrant said: "The Republic has no need of savants." The honor of discovering the mechanical equivalent of heat and laying the foundation of the law of the conservation of energy is divided between the Manchester manufacturer, Joule, and the German village doctor, Mayer. The self-trained Quaker boy, John Dalton, became the founder of the atomic theory. Jefferson was the framer of the Declaration of Independence, president of the United States, founder of the University of Virginia and student of natural history. Franklin was printer, author, envoy from the young republic to France, postmaster general and scientist. The autocrat of the breakfast table was professor of anatomy in Harvard Medical School and his greatest contribution will not be found in his novels or poems, but in his article on the

"Etiology of Puerperal Fever," in which he divides honors with the great Hungarian obstetrician, Semelweiss. It is said of Goethe that he might have been the greatest scientist of his age had he not chosen to be the greatest poet. The man who made the greatest contribution to medicine in the nineteenth century, Pasteur, was not a physician, but a chemist. Elihu Burritt with his knowledge of many languages was a blacksmith. Virchow, the father of cellular pathology, was a socialistic-democrat, a member of the Reichstag and a vigorous opponent of Bismarck.

Permit me to briefly summarize my chief themes: Education is the modification of behavior through experience. The mechanism of learning consists of the nervous system with its sense receptors, conductors, centers and effectors. Education is secured by opening up neural pathways to the brain; this requires effort, but a frequently traveled path becomes smooth and easy. The course of learning does not show a constant ascent, but has occasional plateaus. Special pathways are needed for the acquisition of special knowledge. A fundamental education should include language, mathematics, history and science. No education can be symmetrical without training in all these. Upon these as foundation stones, the tower of special knowledge may be carried as high as the builder can.

Accuracy and promptness in formulating judgment are the ends sought in education; correctness first, and readiness next. When these qualifications are accompanied by the ability to be both prompt and effective in action the individual becomes of highest service to himself and his fellows.

I am aware of the fact that the advice of age does not meet a ready reception in the mind of youth. The old frequently envy youth its opportunities and wish that they were again young. This is idle and besides is not desirable. My generation has enjoyed great privileges. It has been my personal good fortune to know in the prime of life that great Englishman, the founder of antiseptic surgery, Joseph Lister, to sit at the feet of that great German, the discoverer of the tubercle bacillus, Robert Koch, and to look into the face of that greatest of Frenchmen, the man who laid the foundations of preventive medicine, Louis Pasteur. Were the price offered eternal youth, I would not tear from memory's book one page of its golden lessons, and I ask no higher immortality than that there should be found among my students those who have been inspired by my words and works, to carry forward the torch of science to light their fellow-men on their way to wider knowledge and its beneficent rewards.

Man has already accomplished much, but the greater tasks lie ahead. The productivity of the soil must be increased a hundredfold. Grains and fruits, yet unknown, must be grown. The heavy burdens that still oppress the shoulders of labor must be transferred to the tireless muscles of machinery. The literature of the higher civilization is, as yet, unwritten. Laws for which no precedents can be found must be framed and administered. The giant strength of intra-molecular energy must be harnessed into the service of man. A broader morality must govern our behavior, one to another, and a loftier religion must enthuse the common aspirations of the race. All this and much more must be achieved before man fully develops his highest potential greatness.

The world of effort is before you, young men and women. The road ad astra lies per aspera, but bruised heels and aching limbs count for naught when the way leads upward toward the mountain tops of human growth and perfection. Keep to this road, doing what you can to lift yourself and your fellows to a more rational life, and Michigan will have done well in bestowing upon you her richest gift, an education.

VICTOR C. VAUGHAN
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THE USES FOR MATHEMATICS

MATHEMATICS has been termed the handmaiden of the sciences. Whether or not the mathematician himself accepts this as a truthful representation of his beloved science de-

pends upon what the word "handmaiden" connotes. If it is used to designate a supposed inferiority either in value or respect, or a menial and degrading compulsory service, he justly rebels against the use of this metaphor. If, on the other hand, divested of all suggestion of inferiority ordinarily concomitant with the use of the term servant, the word is only construed to mean a voluntary, honorable assistance, then, though deploring the use of a figure with such possibilities for false interpretation, he may not seriously object to its use. Mathematics undoubtedly does render incalculable aid to the exact and many other sciences.

Since mathematics antedates the other familiar sciences, astronomy excepted, its existence is surely not dependent upon their existence, nor can service to the other sciences be its sole aim and object. It does not live to serve, alone. It is not a born slave. It has an existence absolutely independent of any use to which it may be applied. The mathematician has pursued and will pursue his investigations regardless of material profit. The unselfish motive which directs his activities as well as those of other pure scientists is that love of knowledge pure and simple which seeks no reward other than the intellectual delight incident to the discovery of unknown truth, for him the revelation of hitherto unseen relations existent in the realms of number and space. However abstract and remote from practical application the truth revealed, matters not. He is not and refuses to be guided by mercenary motives.

If, however, in the light of popular conceptions, the standard of appreciation of science be the extent or importance of its application to the exigencies of daily life, mathematics gains rather than suffers from the lowering of the standard. Nevertheless the teacher of mathematics is frequently required by the prospective student to justify the usefulness of his courses. It occurred to me that a very definite and unprejudiced reply to such queries can be obtained from the Encyclopedia Britannica, 11th ed. This great work which is a "survey of the field of knowledge" presumably is impartial. Necessarily only the essentials can be given in such a work. We have selected from this book those subjects which have required the symbols of infinitesimal calculus in their treatment. The list is intended to be complete, but omissions are probable, owing to the haste in covering so many pages. Notice of omissions will be welcomed. Some of the subjects, such as infinitesimal calculus, are obviously mathematical, while the appearance of others, such as clock and sky, may surprise even mathematicians. The list would be far greater if we based it upon a lower subject such as trigonometry instead of calculus.

The list contains 104 headings which are as follows: Aberration, accumulator, æther, algebra, algebraic forms, amplitude, astronomy, atmospheric electricity, aurora polaris, ballistics, bearings, Bessel function, bridge, calculating machine, calorimetry, capillary action, chemical action, chemistry, clock, combinatorial analysis, condensation of gases, conduction electric, conduction of heat, curve, cycloid, differences calculus of, differential equation, diffraction of light, diffusion, dynamics, dynamometer, earth figure of the, elasticity, electrokinetics, electrolysis, electromagnetism, electrostatics, energetics, Fourier's series, function, fusion, geodesy, geometry, gravitation, groups theory of, gyroscope and gyrostat, harmonic analysis, heat, Herbart, hodograph, hydraulics, hydromechanics, illumination, induction coil, infinitesimal calculus, interference of light, interpolation, lens, light, lighting, logarithm, lubrication, magnetism, magnetism terrestrial, magneto optics, map, maxima and minima, mechanics, mensuration, meteorology, molecule, number, power transmission, probability, quaternions, radiation, radioactivity, series, shipbuilding, sky, solution, sound, spectroscopy, spherical harmonics, spiral, steam engine, stereoscope, stoichiometry, strength of materials, sun, surface, surveying, table mathematical, tacheometry, thermodynamics, thermoelectricity, thermometry, tide, time measurement of, transformer, trigonometry, units physical, vaporiza-

tion, variations calculus of, vector analysis, wave.

That mathematics is the handmaiden of the sciences is fully confirmed. Only about a fourth of the headings are those of pure mathematics. The wide variation of the subjects is evident. They cover the subjects of five sections of the American Association for the Advancement of Science.

If these facts are pointed out to the students, it will doubtless give them a greater interest in the subjects of mathematics, for even though they can not understand the references they can at least grasp their significance and approach their work with a conviction that it is worth while. It is hoped that this list may prove valuable to teachers in this way.

The student should appreciate early the importance of his mathematical training in his work, particularly in any subject of exact science. The haste made necessary by the limitations of time and the demand for more and more principles leaves little time for the application of known principles to explain nature in a mathematics class. The utility of the subject may thus not be as obvious to the inexperienced pupil as to the teacher. The subject of mathematics should not be considered by the pupil as mere continued drudgery without ultimate gain. When those uninspiring successions of hooks and crooks are clothed with a garb of meaning provided by nature herself and their real import and significance made manifest, they command a proper reverence because of that which they have accomplished. The beauty of the truth revealed or explained sheds a sense of beauty even over the cold abstract reasoning.

The student should know that that which he dimly foresees will appear before him as a panorama of extended beauty over which he can roam when once he has mastered that most wonderful and powerful instrument of modern analysis, discovered by Newton and Leibnitz, and so fully developed and applied by that constellation of immortal mathematicians the Bernouillis, Clairaut, Euler, Lagrange and Laplace, namely the infinitesimal calculus. He will then have a deeper insight into, and a partial comprehension of the plan of nature. Beauty concealed by ignorance of the mathematics necessary for interpretation will be revealed to him. He will then see that of which the untutored mind has no conception because lying beyond its comprehension.

The massive bridge once wonderful because of its enormous size, when its principles of construction are understood becomes a thing of beauty, a wonderful monument to the intellect of the designer and constructor. The great tunnels, turbines, subways are changed to objects of wonder to those who are capable of understanding the difficulties overcome in their construction. The stars in the universe above which nightly dissipate some of their light upon the earth bespeak their Creator's glory in voices but faintly heard by those whose training does not enable them to comprehend the reign of law there prevailing. To such an one the heavens declare the glory of God in a more real and exalted sense. The earth is full of His glory. There will be "sermons in stones."

The extent to which natural laws have been discovered and expressed in mathematical equations must be a source of unending wonder. "Order is heaven's first law." The mathematical equation is the apotheosis of order. It will ever be a matter of self-congratulation to mankind that they can thus interpret natural phenomena by expressing the inexorable laws governing them in equations. We should better say that we are thankful to God for revealing to us those laws to which He has subjected His creation. It must compel a higher order of admiration for the Creator that He has made things thus.

One of nature's demands in which she is inexorable is a study of higher, the highest mathematics. The interpretation of her laws requires it. I close by quoting a scientist of wide fame. Sir John Herschel in the introduction to his celebrated "Outlines of Astronomy" writes:

> The utmost pretension of this work is to place its readers on the threshold of this particular wing of science, or rather on an eminence exterior to it,

whence they may obtain a general notion of its structure. . . . *Admission to its sanctuary and to the privileges and feelings of a votary is only to be gained by one means—sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or in any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.*

Samuel G. Barton
Flower Observatory,
University of Pennsylvania

THE LATE WILLIAM SAUNDERS, C.M.G., LL.D.

In the death of Dr. William Saunders, C.M.G., late director of the Dominion Experimental Farms, which took place at London, Ontario, on September 13, there passed away a notable pioneer in the field of Canadian agricultural investigation, one who had worked hard and successfully in the best interests of his country for more than a quarter of a century and who, we rejoice to say, had lived to see in a large measure the fruits of his labor in a very material improvement of our basic industry, in methods, in crops and in stock throughout the length and breadth of the land. Comparing the agriculture of this country today with that of 1886, when Dr. Saunders entered upon what we may term his life work—the establishment of the Experimental Farm System—it is abundantly apparent that farming in all its branches has developed and prospered and we can not doubt that the varied activities of this system, in research and in the wide dissemination of information among our farmers, carried forward as they have been by Dr. Saunders and his co-workers with enthusiasm and skill, must have played a very important part in this agricultural progress. It has been a valuable and national work, and stands to-day as a monument to the initiative, the unflagging zeal and the untiring energy of Dr. Saunders, who held the directorship of the farms from their establishment to April, 1911, when he retired, owing to failing health and advancing years.

William Saunders was born in Devonshire, England, in 1836, and came at the age of 12 years to this country with his parents, who settled in London, Ontario. In early manhood he studied chemistry and pharmacy and subsequently established a business for the manufacture of pharmaceutical preparations, a business which he successfully carried on till 1886, when it was handed over to his eldest son, William E., who has remained since that date as head of the firm. In 1882, we find that his chemical knowledge had gained for him the post of public analyst for Western Ontario. Previous to that date he had taken a leading part in the founding of the Ontario College of Pharmacy, of which he was president for two years. He was also on the professoriate of the medical faculty of the Western University. His interest in entomology led him to assist in establishing the Entomological Society of Ontario, of which he was president for the period 1883–6. In the practical work of this society he maintained an active and warm interest throughout his life, acting as editor of its organ, the *Canadian Entomologist,* for thirteen years. As a result of his entomological studies, which were mainly of an economic character, he published in 1882 his work entitled "Insects Injurious to Fruit," a book that has been widely used as a text in agricultural colleges and by orchardists in the United States and Canada.

In 1868 Dr. Saunders purchased a small farm in the neighborhood of London and there, it may be said, he laid the foundation of his future work in horticulture, always his favorite study. This area of land, which he planted largely to fruit, enabled him to investigate and observe in the fields of experimental agriculture and horticulture, and no doubt furnished him with those qualities and that knowledge which led to his selection as the one best qualified to undertake the important task of establishing the Experimental Farm system. His many successes in the production of new fruits, flowers and grains during this period testify to his skill as an hybridist of the first rank.

Of his work as head of the Experimental Farms it will only be possible to give the

merest outline, but the annual reports and bulletins of that institution and his papers before learned societies give ample evidence of his active life in agricultural research. We can only refer here, and that briefly, to the results of his work with fruits and cereals.

In gooseberries he produced the Pearl and Red Jacket, both well and favorably known. With black currants he made many crosses and his Eclipse, Magnus Clipper, Climax, Success and Beauty have all established reputations. He crossed the red raspberry with the black cap, but the resulting varieties though of excellent quality and good bearers were not generally acceptable to the fruit trade by reason of their dark color. The "Sarah," however, has proved an excellent variety for home use, being valuable on account of its late fruiting. Early varieties of the red currant of Dr. Saunders's production are the Brighton and Count, both hardy, prolific and good yielders. In grapes, his Emerald, a white grape of fine quality, may be mentioned; it was held to be the best grape of the Canadian varieties exhibited at the Colonial Exhibition in London in 1886.

In ornamental plants he did excellent work, originating two fine and valuable roses, the Mary Arnott and the Agnes. Among the barberries also he left as a legacy several very interesting and highly ornamental hybrids.

His efforts and their results in hybridizing with apples are well known to the horticultural world. He set himself the difficult task of producing an apple that would be sufficiently hardy to withstand the rigor of the winter in our northwestern provinces. Many pages might be filled with an account of his labors in this direction. They were begun in 1894, using as the female parent the exceedingly hardy and exceedingly small wild Siberian crab, *Pyrus baccata,* and as the male parents a large number of hardy Russian and American apples. From these crosses he obtained his first fruit in 1899, and from among the bearing trees he found some that would justify their propagation. About 800 trees were set out and many of them have proved hardy and have fruited abundantly on the open prairie. Their fruit showed a very considerable increase in size, as compared with that of the mother parent, some of them having a diameter of one and three quarters inches. Among these first crosses stand out the Jewel, Sylvia, Prince, Tony, Elsa and Charles. Fruit of these has been produced at Fort Vermilion, in latitude 58°, where the winter temperature may fall as low as 60° below zero Fahrenheit.

From this initial work Dr. Saunders pushed forward, seeking apples of larger size and better quality. Taking the larger, he recrossed these hybrids with several hardy apples of well-known varieties and produced a number of still greater promise. Of these second crosses he planted about 400 trees, some of which have borne fruit two and a half inches in diameter and of good quality. These are now under test on the prairie farms and it is confidently expected that many of them will prove of value where apples can not at present be successfully grown.

In his work with cereals—a work which has proved of paramount importance and value to Canada—Dr. Saunders's endeavor was to produce an early ripening wheat of good quality, that might serve for districts in the Canadian northwest where the Red Fife, our standard variety, was in some seasons injured by early autumnal frosts. The story of this wheat breeding is a long and interesting one, covering many years of patient, skilful work. Many hundreds of hybrids have been produced and tested at the Central Farm. Hundreds have been discarded in the course of this investigation and hundreds were tried out for prolificness, earliness and bread-making qualities. Of this large number a few, perhaps a dozen, have been found worthy of introduction, and these, all crosses from the standard varieties, Red Fife and White Fife, are now well known and widely cultivated. Some mention must be made of the more important of these new wheats, which are all vigorous, productive and early in ripening. Preston and Huron are bearded, the equal of Red Fife in hardness and color. Stanley is a beardless wheat and in some respects from the commercial point of view perhaps somewhat infe-

rior to the foregoing varieties. Of somewhat different parentage is the next to be referred to and the best of them all—the Marquis—derived by crossing the Red Fife with the Hard Red Calcutta. Marquis, that practically from its first introduction, leaped into popularity and stands to-day as the equal of Red Fife in bread-making qualities and vastly superior to it as regards earliness in ripening. The selection of this splendid wheat, from a number of unfixed but closely related types, is the outcome of much painstaking and careful work on the part of Dr. Saunders's third son, Dr. Charles E. Saunders, who as Dominion Cerealist at Ottowa, took up this phase of his father's work in 1903. The Marquis has more than fulfilled the most sanguine expectations, and farmers and millers alike speak most enthusiastically of its many fine qualities and its extreme earliness. It has given excellent yields in Manitoba, Saskatchewan and Alberta, but not only is it a heavy cropper, but its grain is heavy and of excellent appearance, practically undistinguishable in all good qualities for milling and baking from Red Fife. It resists well adverse weather conditions. In earliness of ripening it is ready for harvesting from 5 to 10 days before Red Fife, a matter of no small importance for districts subject to early autumnal frosts. Such a combination of good qualities easily accounts for its success with farmers and its great popularity. It is rapidly replacing all the older early maturing wheats, including the Red Fife, on our western prairies. It won the prize of $1,000 given at the land exhibition in New York City in 1911, for the best 100 pounds of wheat grown on the continent of North America, and in 1912 was the successful competitor for the $2,500 prize awarded by the Dry Farming Congress held in that year at Lethbridge, Alberta. In 1913 it again received the highest award at the Congress held in Tulsa, Okla. We may thus safely say that the problem that Dr. Saunders set himself, to produce a good wheat with an early maturing habit suitable for general cultivation in the Canadian northwest, has been successfully solved. The production of the Marquis wheat has demonstrated the value of research work in agriculture and increased our possibilities as a wheat-growing country. Its value to Canada is scarcely to be calculated in thousands of dollars.

Dr. Saunders was a great lover of the beautiful in the out-of-doors, and to adorn the grounds he had charge of he introduced from other countries many shrubs and flowers. His planning and planting of the grounds and arboretum of the Central Farm and of much of the Government Driveway, at Ottawa, testify to his skill and good taste in landscape gardening.

Dr. Saunders's achievements were widely recognized. For his valuable work in promoting the interests of Canadian agriculture he was the recipient of many honors from learned societies and universities at home and abroad. He received the honorary degree of LL.D., from Queens University in 1896, and the University of Toronto bestowed on him the same honor in 1904. In 1905 he was created by His Majesty, the late King Edward VII., a Companion of the Most Distinguished Order of Saint Michael and Saint George. He was a Fellow of the American Association for the Advancement of Science, Fellow of the Linnean Society of London, Corresponding Member of the Royal Botanical Society, Fellow of the Chemical Society (London, Eng.), and held a membership in many other societies devoted to the natural sciences.

The *Transactions of the Royal Society of Canada,* of which Dr. Saunders was made a charter member on its formation in 1882, contains many contributions from his pen. The titles of some of these are "The Introduction and Dissemination of Noxious Insects," "The Importance of Economizing and Preserving Our Forests," "The Influence of Sex in the Hybridizing of Fruits," "Early Ripening Cereals," "Progress of Experiments in Cross-fertilizing at the Experimental Farms," "Results of Tree Planting on the Northwestern Plains," "Increased Production of Farm Crops by Early Sowing." These titles indicate his wide interests in economic phases of

agriculture. He was honored by election to the presidency of the Royal Society in 1906.

Dr. Saunders possessed a pleasing personality and was much beloved by those who knew him well. He was kind and considerate to all and ever ready to listen and help those who came to him for guidance and assistance. He was a good administrator, consistent, quiet and firm, with an excellent judgment of men and affairs, and these qualities no doubt contributed largely to his success as chief officer of the Experimental Farms. He never exaggerated to force home a truth, no matter how important it was, but contented himself in all his writings with a plain statement of the facts as observed and of the deductions that might safely be drawn therefrom. Anything of the spectacular or sensational, for the purpose of publicity or advertisement, were particularly abhorrent to him.

The name of Dr. Saunders is honorably and inseparably identified with the establishment and work of the Dominion Experimental Farms. To this end he labored long and earnestly and, as is well known, successfully. Canada gladly and gratefully acknowledges the benefits which those services have bestowed upon her agriculture.

Frank T. Shutt

THE MUSEUM OF VERTEBRATE ZOOLOGY OF THE UNIVERSITY OF CALIFORNIA

Among the research museums of America is one which in view of the brief period of its existence and the relatively small fund available for its maintenance has made such phenomenal growth and published such important results that it deserves the consideration and respect of all American naturalists. I refer to the Museum of Vertebrate Zoology of the University of California. This institution is only six years old, having been established in 1908 through the liberality and public spirit of Miss Annie M. Alexander. For years previously Miss Alexander had been engaged in amassing collections of West Coast mammals, and had conducted important expeditions reaching northward far into Alaska. There being at the time no museum on the Pacific coast with which she could cooperate in building up the splendid research collections she had in view, she sought and obtained the cooperation of the State University at Berkeley. During the first year a temporary building was erected, the cost of which was shared equally by the university and Miss Alexander.

Modern work in systematic zoology has demonstrated over and over again the futility of attempting critical studies of the relations and variations of species, or of the problems of their distribution, without the illuminating aid of large series of specimens from many localities. Keenly alive to this need, Miss Alexander, by her own efforts and those of her assistants in the field, has already brought together the largest collections ever made of West Coast terrestrial vertebrates—collections sure to be of inestimable and increasing value as time goes on. Her field explorations have extended from the deserts and mountains of southern California northward and westward to Prince William Sound in Alaska. Among the areas already worked in detail are the great interior valley of California, the Colorado Desert and other deserts and mountains of southern California, Owens Valley, the Mt. Whitney region, the Trinity Mountains in northern California, Humboldt Bay on the northwest coast, the Modoc and Goose Lake region of northeast California, certain mountains and deserts in northern Nevada, Vancouver Island and other parts of British Columbia, and the Sitkan and Prince William Sound regions in Alaska.

The magnitude of the collections—consisting mainly of birds, mammals, reptiles and batrachians—is surprising in view of the relatively brief period covered by the field work, the museum already containing more than 21,000 mammals, about 25,000 birds, more than 1,300 sets of birds' eggs, and upwards of 5,500 reptiles and batrachians.

Based on these rich collections, the university has issued a series of highly important faunal and systematic papers, illustrated by plates, text-figures and maps, some treating of the faunas of special areas, others of the species of particular groups. In nearly all cases

these contributions possess the merit and freshness of having been written by the men who actually did the field work on which they are based. The authors are Joseph Grinnell, the able and energetic director of the museum, and several assistants, past and present, namely, Harold C. Bryant, Joseph Dixon, Edmund Heller, Frank Stephens, Harry S. Swarth, Walter P. Taylor, and Miss Louise Kellogg.

The museum has adopted a most liberal policy in regard to the loaning of specimens, so that responsible naturalists engaged in revisions of groups may have the benefit of its material. In my own case, particularly in my studies of the big bears of Alaska, of which Miss Alexander has amassed the largest and most important collection in existence after that of the United States Biological Survey, I have enjoyed such unusual courtesies in the unrestricted use of specimens and field notes that I feel it a privilege as well as a duty to make this slight acknowledgment of the generosity and spirit of cooperation shown both by the founder and the director of the museum.

C. Hart Merriam

SCIENTIFIC NOTES AND NEWS

The American Society of Naturalists, in affiliation with the American Society of Zoologists, the Botanical Society of America, and the Society of American Bacteriologists, will hold its thirty-second meeting at Philadelphia, under the auspices of the University of Pennsylvania, on Thursday, December 31. The morning session will be open for papers on evolution, genetics and related subjects from members or invited guests. The program of the afternoon will be a joint symposium with Section F of the American Association for the Advancement of Science on "The Value of Zoology to Humanity." The annual dinner will be held in the evening of the same day.

The American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, the American Society for Experimental Pathology and the Society of American Naturalists, will meet in the laboratories of the Washington University, St. Louis, on December 28, 29 and 30.

The New York Academy of Sciences and its affiliated societies had a general meeting at the American Museum of Natural History, on Monday, November 2, when Professor Reginald A. Daly, of Harvard University, gave a lecture on "Problems of Volcanic Action," which was followed by a reception.

Professor William Henry Bragg, who holds the chair of physics at the University of Leeds, is giving a course of four lectures on X-rays and crystals at Brown University, as part of the celebration of the hundred and fiftieth anniversary of its foundation.

Dr. Felix von Luschan, director of the Royal Museum of Ethnology in Berlin, and professor of anthropology in the University of Berlin, who was a guest at the Australian meeting of the British Association, is at present in this country, having been unable to return to Germany. He lectured last week at the University of Chicago.

Professor David Todd has returned to Amherst College, having made successful photographs of the corona of the recent solar eclipse from the estate of Count Bobrinsky, about a hundred miles southeast of Kieff. Owing to the mobilization, his instruments did not arrive in time, but he was able to obtain a camera and lenses that could be used.

Dr. Cyril G. Hopkins, head of the department of agronomy of the University of Illinois, has returned to his work after a year's leave of absence. Dr. Hopkins during the last year has been working for the interests of the south with the "Southern Settlement and Development Association," with headquarters at Baltimore.

President A. C. Humphreys, of the Stevens Institute of Technology, will act as president of the International Gas Congress, which meets in San Francisco next September.

The Alvarenga Prize for 1914 has been awarded by the College of Physicians of Philadelphia to Dr. Herman B. Sheffield for an essay entitled "The Fundamental Principles

involved in the Use of the Bone Graft in Surgery."

Sir Almroth Wright has been appointed consulting physician to the British army in the field.

Mr. Herbert K. Job, who for the past four years has been state ornithologist of Connecticut and lecturer on ornithology at the Connecticut Agricultural College, has resigned to take up work along similar lines for the National Association of Audubon Societies.

Dr. Grace L. Meigs has been appointed by Miss Julia Lathrop, chief of the children's bureau of the U. S. Department of Labor, as expert on sanitation on the staff of that bureau. Dr. Meigs has recently been attending physician in children's diseases in Cook County Hospital, and will act in a general advisory capacity to the bureau in matters of child health and hygiene.

Professor W. K. Hatt, of Purdue University, has been appointed by the county commissioners of Marion County, to report on the design of the West Washington Street bridge over White River at Indianapolis.

Dr. M. A. Rosanoff, professor of research chemistry in the Mellon Institute of Industrial Research, University of Pittsburgh, will give a series of about twenty-five lectures on the general subject "Equilibria in Heterogeneous Systems" beginning Tuesday evening, November 3, 1914.

Professor Vernon L. Kellogg, of Stanford University, is giving in November a series of four lectures on "Heredity" before the Associated Charities of San Francisco.

Professor William E. Ritter, of the department of zoology of the University of California and director of the Scripp's Institute for Biological Research, addressed on November 4 members of the zoological department, graduate students and faculty members at the University of Illinois on the work of the institute.

Mr. G. R. Mines, fellow of Sidney Sussex College, Cambridge, and professor of physiology in McGill University, died on November 7, at the age of twenty-nine years. Professor Mines died while making experiments in his laboratory on the action of the heart, apparently as the result of some failure in the apparatus.

Dr. Henry Gannett, geographer of the U. S. Geological Survey since 1882, president of the National Geographic Society, the author of contributions to typographical surveying, statistics and geography, died in Washington on November 5, aged sixty-eight years.

Dr. Friedrich von Graner, director of the Forestry Bureau in Stuttgart, has died at the age of sixty-eight years.

At the meeting of the Association of American Universities, held at Princeton University last week, papers were presented by President George E. Vincent, of the University of Minnesota, on "The Granting of Honorary Degrees"; by Mr. George Parmly Day, treasurer of Yale University, on "The Function and Organization of University Presses," on "State Agencies of University Publication," prepared by Professor John C. Merriam, University of California, and presented by Dean Armin O. Leuschner, and on "Economy of Time in Education," by President A. Lawrence Lowell, of Harvard University.

The seventh annual meeting of the American Institute of Chemical Engineers will be held in Philadelphia, Pa., from December 2 to 5. A program of excursions to a number of the large chemical manufacturing plants in and around Philadelphia is being arranged. A number of addresses and papers on "The Present Opportunities for American Chemical Industries" will be delivered by prominent chemical engineers and business men.

The New England Geological Excursion, which was announced for October 16–17, was given up on account of rain.

Governor Eberhart, of Minnesota, has issued a proclamation setting aside the week of November 29 to December 5 for the study of general health problems.

In accord with the unanimous vote of the first Pennsylvania Industrial Welfare and Efficiency Conference held in Harrisburg last year, John Price Jackson, commissioner of labor and industry, has issued a call for a sec-

ond conference to be held in the State Capitol at Harrisburg on November 17, 18 and 19, 1914. This conference is held under the auspices of the Pennsylvania Department of Labor and Industry and the Engineers' Society of Pennsylvania. The purpose of the conference is to enable the employers and employees to work out together the problems before them with reference to increasing the welfare of the employees and the prosperity of the industries. The conference last year was attended by approximately two thousand persons, many of whom were leaders in the labor and industrial world. The first session of the second conference will be called at 10 A.M. on November 17, and the meetings will close at 5 P.M. on November 19. The various sessions of the conference will be held in the State Capltol, Harrisburg. In connection with the conference proper, will be held a Safety, Welfare and Efficiency Exhibition which will open on the morning of November 16 and close on the evening of November 20.

We learn from the *Journal* of the American Medical Association that the Wesley Memorial Hospital of Chicago has established five fellowships to be given yearly to those graduates in medicine who have clinical scientific problems that they wish to solve. The work will be done under a joint board made up from the staff of the Wesley Hospital and the laboratory departments of the Northwestern University Medical School; the clinical work to be done in the hospital and the laboratory work in the laboratory of the medical school. The problems are restricted to those having direct application to clinical medicine and surgery or the specialties. The fellowships are open to any graduate in medicine. The recipient of the fellowship will be required to devote his entire time during the first year, at least, to the prosecution of his investigation.

Professor I. W. Bailey, of the Harvard Forest School, has returned to the Bussey Institution after an absence of several weeks spent in visiting a number of the middle western universities. The following papers, prepared in collaboration with Dr. E. W. Sinnott, were read by Professor Bailey:

University of Chicago, October 12: "The Effects of Decreasing Temperatures upon the Form and Structure of the Angiosperms."

Meeting of Central Botanists, St. Louis, October 17: "The Origin and Dispersal of Herbaceous Angiosperms."

Missouri Botanical Garden, October 21: "Some Problems in Phytogeography."

University of Wisconsin, October 26: "The Effects of certain Changes in Climate upon Arborescent Angiosperms."

University of Michigan, October 30: "Recent Educational Developments in Forestry and Lumbering."

A meeting of the New York Section of the American Electrochemical Society was held on November 10 in Rumford Hall to discuss "Contributions of Chemistry to Illuminating Engineering." The program was as follows: Milton C. Whitaker, Columbia University: "The Improved Incandescent Gas Mantle"; William C. Moore, National Carbon Co.: "Chemistry in the Development and Operating of Flaming Arc Lamps"; Ralph E. Meyers, Westinghouse Lamp Co.: "The New Tungsten Lamps"; R. D. Maily, Cooper Hewitt Electric Co.: "The Quartz Mercury Lamp"; D. McFarlan Moore, Edison Lamp Works: "The New Moore Tubes."

Pennsylvania so far exceeds all the rest of the states in the value of its mineral products as to stand almost alone. Exclusive of the value of pig iron, coke and other derived or secondary products not included in the total, the value of Pennsylvania's mineral production is nearly one fourth that of the entire country; and in 1913, according to figures of the United States Geological Survey computed in cooperation with the Pennsylvania Topographic and Geologic Survey Commission, it equaled the combined value of the production of West Virginia, Illinois, Ohio and California, the next four states in the value of their mineral product. Pennsylvania derives its mineral wealth almost entirely from nonmetalliferous mining operations. Except for a small amount of copper it produces none of the precious or semiprecious metals, and the only other metal which figures in the total production of

the state is iron, of which a small quantity (less than 500,000 tons of ore in 1913) is mined. In addition, however, to being the premier state in the production of coal, Pennsylvania leads also in the manufacture of cement, the burning of lime, and the production of mineral paints, sand, slate and stone. It is second in the value of clay products and natural gas, and sixth in the production of petroleum. Although not an iron-ore state, Pennsylvania is by far the leading producer of pig iron, which is obtained from the Lake Superior ores. The production in 1913 was 12,871,349 long tons, valued at $197,726,314. If the value of the pig iron made in Pennsylvania were added to the value of the other products of the state, the total values for 1913 would have exceeded $700,000,000, which is more than one fourth of the value of the total mineral production of the United States. The production of coal in Pennsylvania in 1912 amounted to 246,227,086 short tons, valued at $346,993,123; in 1913 the value was $388,220,933, an increase of $41,227,810, or 12 per cent., over 1912. Second in importance among Pennsylvania's mineral industries is the manufacture of Portland cement, closely followed by the clay-working industry. The production of cement in 1913 was 28,060,495 barrels, valued at $24,268,800, against 27,625,340 barrels, valued at $18,945,835, in 1912. The value of the clay products, exclusive of raw clay mined and sold, increased from $21,537,221 in 1912 to $24,231,482 in 1913. Although ranking second in the total value of its clay products, Pennsylvania is first in the production of brick and tile. A large part of the fire clay is mined in connection with coal mining and becomes in reality a by-product of that industry.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. W. K. Vanderbilt has given $135,750 toward the purchase by Columbia University of a half block of land on 117th Street adjoining other land owned by the university.

The University of Pennsylvania receives $50,000 by the will of Miss Anna Blanchard of Philadelphia.

The late Dr. Morris Longstreth, who at one time held the chair of pathological anatomy in Jefferson Medical College and later was in practise at Cambridge, Mass., and Barcelona, Spain, made the College of Physicians of Philadelphia his residuary legatee.

The annual dinner of the faculty and managers of Haverford will be held on November 23, when questions relative to the curriculum and the general policy of the college will be discussed.

Dr. William Waddell Boyd was inaugurated president of the Western College for Women, Oxford, Ohio, on November 4. His inaugural address was entitled "The Intelligent Use of the Intellect."

A cablegram to the N. Y. *Sun* states that M. Henri Bergson, presiding at a meeting of the Academy of Moral and Political Sciences on November 7, announced that Arthur Raffalovitch, Russian privy councillor and attaché of the Russian Embassy in Paris, a correspondent of the academy, has given his library, which he has been collecting for thirty years, to the University of Louvain. M. Bergson added that a committee is being formed to reconstitute the library's funds. It is known that the Germans removed the most precious manuscripts before burning the library, so it is hoped that the treasures eventually will be restored to Louvain.

The Medico-Chirurgical College of Philadelphia has, according to the *Journal* of the American Medical Association, made the following faculty changes: Dr. Herbert H. Cushing, professor of practical anatomy; Dr. Ardrey W. Downs, professor of experimental physiology; Vernon K. Suydam, professor of physics; Charles E. Vanderkleed, professor of analytical chemistry; Dr. John H. Small, associate professor of bacteriology; Dr. Eugene A. Case, associate professor of pathology; Dr. Philipp Fischelis, associate professor of histology and embryology; Dr. Guy Hinsdale, Hot Springs, Va., associate professor of climatology; Dr. Arthur C. Morgan, associate professor of medicine, and Dr. John Stewart Rodman and Dr. John J. Gilbride, associate professors of surgery.

Dr. Johannes Meisenheimer, associate professor at Jena, has been elected professor of zoology at Leipzig, to succeed the late Professor Chun.

Dr. Paul Koebe, associate professor at Leipzig, has been elected professor of mathematics at Jena, as successor of Professor Johannes Thomae.

DISCUSSION AND CORRESPONDENCE

SUNFLOWER PROBLEMS

Professor Bateson, in his British Association address (Science, Aug. 28, 1914, p. 300), has raised the question whether the red sunflower may not owe its chestnut color to the loss of an inhibitor, instead of the positive addition of a factor for red. Are all yellow-rayed sunflowers potentially red, but prevented from becoming so by something which "stops down" the series of chemical processes which would produce redness?

So far as I can determine, the cultivated *Helianthus annuus* is derived from the wild *H. lenticularis,* which has a dark disc and orange rays. The disc florets of this plant have small triangular lobes, which are a sort of dull wine red owing to an abundance of anthocyan pigment. The rays are orange, without red. The disc bracts have dark red ends. There is evident anthocyan pigment in the stem, producing a mottled effect. Thus, it is clear that the *kind* of pigment which characterizes the red sunflower is rather abundantly present in the wild plant, although it does not invade the rays. Occasionally, however, the rays show a little red. At Longmont, Colorado, August 30, 1914, I found a plant of *H. lenticularis* having the middle third of the rays beneath with the apical half variably light brownish-red. Microscopic examination showed cells with anthocyan, which became redder with acid. On the upper side, the rays were entirely orange as usual. In the red sunflowers, it is this middle tract of the under side of the rays which is generally especially heavily pigmented. Had this Longmont plant a special "factor for red," or had some of the effects of the normal reddening factor of the disc florets spilled over, as it were, on to the rays? In our red sunflowers, we find that the heterozygous forms may be very richly colored. Nevertheless, they may be almost wholly yellow-rayed. The most extreme case of this sort is a plant grown this year, which has very purple stems and branches, but the very rich orange rays apparently wholly without red, though a lens shows a little scattered red. In this case it would seem natural to think of the red being inhibited. However, the appearance of yellow-rayed heads at the end of the season on heterozygous more or less red-rayed plants suggests not so much the late development of a special inhibitor, as the failure under adverse conditions of the color-producing mechanism. In other words the "inhibitor" here is nothing more than the withdrawal of the needful stimulus.

The monocephalous garden sunflowers have the disc yellow, the red having disappeared from the disc florets. The same variation occurs from time to time in the related wild species (*e. g.,* the variety *phenax* of *H. petiolaris*). Dark disc is strictly dominant or epistatic to yellow. Here we naturally speak of the loss of a factor; but carrying the inhibitor postulate a little farther, we can assume that we have here a second inhibitor, acting upon the disc, only operating when the plant is homozygous for it. A supposition of this sort is certainly fatiguing to the imagination.

In homozygous red-rayed sunflowers, the pigmentation may be intense.[1] We not only have the form (var. *ruberrimus,* nov.) with the rays deep chestnut red all over; but this year we obtained one (var. *niger,* nov.) with the rays practically black above, slightly red apically, though beneath they showed on one side a streak of orange. (The orange streak on one side, not always the same side, beneath, is a regular character of the very red varieties. I am not at present able to explain this asymmetry, unless it has to do with the manner

[1] It is singular that the pigmentation of the seed (fruit) follows quite different lines. Sutton's tall primrose variety of *H. annuus* has long black seeds, and in a cross with brown-seeded varieties, the seeds of F_1 come broad and dark brown.

of folding in the bud, whereby one side is deprived of light.)

In the vinous series (red on primrose) we have corresponding forms, one (var. *vinosissimus,* nov.) having the rays entirely dark wine red.

On the whole, and in view of the fact that there are no wild species of sunflowers with red rays, it seems reasonably certain that the red represents a "positive" variation; but, as with color variations in animals, there may well be also a diluting or inhibiting factor, which when present sensibly modifies the expression of the factor for red. It is not necessary, however, to suppose even this, since various degrees of stimulation might equally bring about the results. Miss Wheldale, describing analogous cases in chemical terms, suggests that if the local oxidizing capacity of any tissue is greater than its reducing power, this is indicated by the local appearance of anthocyanin; if the reducing power is greater than the oxidizing power, no pigment results. Thus, she says, the *loss* of a dioxidizing factor would produce color, as may be the case in the red-leafed beech.

Duggar found that in the tomato a red pigment (lycopin) and a yellow (carotin) both occur. In yellow varieties only the carotin occurs; but in genetically red varieties a high temperature precludes the formation of lycopin, and yellow fruits result. In the case of the red sunflowers, the red color very commonly fades more or less after the flowers open, probably in part owing to growth without corresponding increase of pigment, which thus becomes diluted. Dr. J. R. Schramm of the Missouri Botanical Garden informs me that in the hot summer of St. Louis this fading is excessive, good red forms becoming practically yellow before they are over. Also, on comparing notes with Mr. D. M. Andrews of Boulder, Dr. Schramm observed that roses with pale tints are much less colored at St. Louis than in Colorado.

With regard to a possible "dilution" factor, it is to be noted that in the series of yellow and orange pigments, which occur in visible particles, dilution can be seen, as explained in SCIENCE, August 21, 1914, p. 284. More recently we have obtained the fourth possible combination of this series, dilute orange, in plants of the *bicolor-vinosus* type.

In the paper just quoted, irregularities in the distribution of anthocyan pigments were described. I have now to record a similar peculiarity in which the solid pigments are involved. An F_2 plant from very pale *Helianthus cucumerifolius* $\times$ *H. annuus coronatus* had broad orange rays, with about the basal half strongly washed with chestnut. A single ray, however, was primrose color, slightly streaked with vinous. This ray had an orange longitudinal stripe on the under side. The difference here is only in the yellow, the difference in the red (chestnut and vinous) being entirely due to the character of the background.

A few words may be added regarding gigantism. In 1913, and again in 1914, there appeared among our red sunflowers a certain number of gigantic plants, fully ten feet high, nearly always with yellow rays. These numbered perhaps about 25 per thousand plants. The occurrence of these plants this year has been especially striking, in a large group of very good reds. One occurred, blooming very late, in the series of F_2 plants from *primulinus* $\times$ *coronatus*, which gave us our first vinous. Have we here a sort of jack-in-the-box effect, some inhibitor of growth being lacking in a certain number of cases? The *coronatus* we used had some "Russian" (var. *macrocarpus* D.C.) in its ancestry, which might bring a recessive tendency to gigantism. These large plants, however, were much branched and had dark discs.

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X-RAY DIFFRACTION PATTERNS

THE diffraction patterns discovered by Friederich, Knipping and Laue have been shown to be due to the arrangement of the atoms of crystals into planes. These patterns are used to indicate the spatial distribution of atoms in crystals.

An experiment illustrating these patterns can be very easily shown to an audience by permit-

ting a beam of light to enter a dark room and fall upon the face of a diamond such as used in rings. The diamond is held a few inches from the hole through which the beam of light enters and upon this screen is thrown a large number of bright spots very closely resembling the X-ray patterns. By moving the diamond to and fro from the screen or by rotating it the form of the pattern can be altered. The portions of rays that enter the diamond and are reflected from the rear surfaces may show the spectral colors.

This experiment can be demonstrated to a class very easily and should be of some use in explaining crystalline structure.

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A NEW METHOD OF PREPARING SPIDERS FOR EXHIBITION IN MUSEUM GROUPS

The preservation of spiders for museum purposes has always presented serious difficulties on account of the fact that the abdomens of the Arachnids lose their shape and color on drying. The usual method of preservation in liquids is of course out of the question when spiders are to be used as part of a faunal group. By preparing an artificial abdomen of wood and fastening it to the cephalothorax of the actual specimen I have found it possible to produce an imitation which can scarcely be distinguished from the living animal.

A large number of specimens of the desired species must be collected, to allow for the selection of full-grown animals. It is advisable to keep them alive for several days and to supply them with plenty of food; as it often happens that either conditions of the weather do not allow an ample food supply or else the insect may be abnormal on account of a recent or impending molt. In such instances the abdomen may often be not quite half the size of that of a well-fed specimen or one filled with eggs.

After the insect body is fully developed, the imitation abdomen must be made before killing. For this purpose a piece of light soft wood is used, carved in the exact form and size. Then the coloration is put on in precise shade and pattern.

Next the spider is killed. The best way to kill it is by putting it in a corked bottle containing cyanide. According to the strength of the cyanide and the size of the spider this takes from one to two hours. If the length of time is not sufficient the spider may later recover. After being sure that the spider is dead an insect pin is driven through the center of the cephalothorax and the insect fastened into a cork sheet, the legs being put in position and supported with pins. After being prepared in this manner, the insect must be kept in a warm and dry place, protected from dust.

After a few days, when the insect is thoroughly dry, the shrunken abdomen may be carefully removed and replaced by the wooden model.

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American Museum of Natural History,
New York

SCIENTIFIC BOOKS

Igneous Rocks and Their Origin. By Reginald Aldworth Daly, Sturgis-Hooper Professor of Geology, Harvard University. New York and London, McGraw-Hill Book Company, Inc., 1914.

In a previous publication Professor Daly expressed the opinion that "to be more productive geology should be more speculative." In this sense the author has become highly productive. In the introduction to his book on "Igneous Rocks and Their Origin," which is an elaboration of his previous publications, he qualifies the estimate commonly put on the value of experimental research in physics and chemistry by remarking that, while the mathematical methods employed are precise the premises relied on are not. How much lower value then must be placed on the results of a procedure in which both the premises and the mode of reasoning are seriously at fault!

The author pays a just tribute to the effectiveness of a regulated imagination, but fails to warn the student of the havoc which may be wrought by a badly regulated one, which like a defective aeroplane may bring destruction not

only to the aviator but to those who may be under him; a simile suggested by his observation that geology is "a science involving long excursions into space." It is to be hoped that in his contributions to higher education Professor Daly will keep this risk constantly before his readers.

His statement that "science is built on a long succession of mistakes" is inexact. Very serious mistakes have been made in the past, and obviously are being made still by those who are earnestly endeavoring to build it up, but it is to be hoped that very little of the structure of modern science is built upon mistakes. It is true as the author says that "their recognition means progress." Most surely, perhaps, when we recognize our own, for "thus we rise on stepping stones of our dead selves to higher things."

The author seems to be outside of petrographical conceptions when he imagines that "science is drowning in facts." The solid facts of petrology should furnish the best building material for a scientific structure, as well as for a foundation, and are not in such a flux as his metaphor suggests. There are many evidences in the book before us that its author confuses facts and subjective conceptions or hypotheses about them; indeed, he closes the introduction with the statement that "The 'facts' of to-day are the hypotheses of yesterday." and he demonstrates his confidence in this assertion by citing as facts in one chapter what were his own hypotheses in a previous one.

In his zealous endeavor to advance the science of petrology Professor Daly has the earnest sympathy of his fellow workers, however much some of them may disagree with him as to his methods of thought and of presentation, or as to his assumptions and conclusions, but the present writer is somewhat at a loss as to how one should interpret Professor Daly's statement that "the best sympathy is expressed in constructive criticism." If this means that the construction should be an elaboration of his hypotheses and theories, then the reviewer regrets that his sympathy is not of that kind. However, if constructive criticism consists in the presentation of other hypotheses, built with the aid of the imagination on other premises, which seem to the writer to be more secure and more in accord with modern conceptions regarding the physics of the earth and the essential characteristics of igneous rocks and their molten magmas, then he would present Professor Daly with the views expressed in the writer's recent lectures on volcanism at Yale University as a token of his sympathy, and would ask him to look upon the present criticism of his work on "Igneous Rocks and Their Origin" as an evidence of the serious concern which the writer feels for the science which both of us are striving to promote, and of his sense of duty in pointing out what seem to the writer some of the mistakes of method employed with such dangerous effectiveness by the brilliant but, as it seems to the writer, mistaken author of the volume in hand.

Since the book is an elaboration of papers already published by the author, which are familiar to most students of petrology, it will not be necessary to state at length the contents of the work which are given in a brief abstract in the first chapter, from which may be gotten more definite ideas of the author's views than are obtainable in some instances from the involved discussions in subsequent chapters. Moreover, the book is so full of statements, citations and tabulated material, much of which is open to criticism and debate, that it would require an exhaustive treatise to discuss the whole work thoroughly. The volume represents a great amount of energy and thought expended through years of study and speculation, evidences of which may be found in extensive tables compiled to illustrate the author's hypotheses, as well as in abundant bibliographic references which must represent but a small part of the author's researches into the literature of petrology, a large part of which would seem to be of little value for his purpose.

It seems to the writer that the most fundamental feature of the book is the mistaken method employed by its author in his attempts to solve the problems of volcanism,

which involve the character and origin of igneous rocks and their antecedent magmas, a method which is disclosed by the construction of the book, as well as by the statements of the author regarding it. The work is divided into three parts. The first broadly treats of what the author considers the facts which need explanation in a philosophy of igneous rocks. The second contains a general, "eclectic" theory of the subject. The third outlines the results of applying this theory to the so-called "facts" previously mentioned.

By way of introducing the "facts" in the case the author devotes a chapter to the Classification of Igneous Rocks, and thereby reveals his lack of acquaintance with some of the fundamental principles of modern petrology, those based on the physical chemistry of crystallizing solutions so far as known. The chapter also demonstrates the inexactness, or incoherence, of his logic, or his indifference to the meaning of words, for on page 2 he says that "Reasons are stated for preferring a classification founded on actual mineral composition," and on page 9 it is shown that it is not possible to determine the actual mineral composition of igneous rocks, and that recourse must be had to chemical analyses. He then proceeds on the assumption that a collection of rock analyses grouped by Rosenbusch according to Rosenbusch's system of mineralogical classification is a classification according to the mode of a rock, the mode having been defined as the actual mineral composition of a rock expressed quantitatively. Rosenbusch himself states that his classification is based on the most noticeable minerals, in porphyritic rocks, with little or no regard in some instances to the minute minerals in the groundmass, which may form a large part of the rock. The author's misuse of the term mode as well as his statements regarding the Quantitative System of Classification, which he calls the Norm System, show plainly his failure to comprehend the fundamental principles both of this system of classification and of the chemico-mineralogical relations in igneous rocks on which the system was founded. This is further shown by his effort to indicate its methods by a hypothetical jumble of biological species.

The author pays a high tribute to the leadership of Rosenbusch in connection with rock classification, whose system he professes to adopt, with modifications of his own, but he violates absolutely the essentials of the system in the third part of his book, and he ignores Rosenbusch's judgment on principles which conflict with the main thesis of his "eclectic" theory. Rosenbusch based his system on the microscopical petrography of igneous rocks, in which branch of petrology he was the acknowledged leader, and it was not to be expected that in the later years of his brilliant career he would have undertaken to reconstruct his system of classification in the light of new discoveries in allied branches of science. But it must not be supposed that he had no appreciation of the march of events; toward new or revolutionary ideas he held a conservative course, and upon one occasion in a discussion of new ideas with which he was in sympathy he remarked to the present writer that he must not introduce such changes into his book suddenly, but gradually in successive editions, for otherwise his readers would not follow him. On the same occasion he volunteered the remark: "I do not know what the future petrography will be, but it will be quite different from what it is now," in 1890. It was as though this great leader of a wandering people had had a vision of a land into which he himself was not permitted to enter.

For the rocks grouped together by Rosenbusch Professor Daly calculates average analyses, chiefly from the tables of analyses published by Osann, and assumes that these averages represent types of each group, the subjective character of such calculations not being considered by him as objectionable. A fundamental error in his procedure with respect to igneous rocks appears in the misstatement, copied from Rosenbusch, that coarse-grained intrustive rocks differ from their corresponding porphyry and lava forms by the relative proportions of their chemical constituents.

This error vitiates some of the fundamental hypotheses developed in subsequent parts of the book (p. 229). It has been clearly demonstrated that these supposed differences rest on the failure of the qualitative system of Rosenbusch to classify rocks by their actual mineral compositions, or modes, and also upon the fact that the modes of chemically similar magmas may differ because of the different physical conditions which may have controlled the chemical equilibria within solidifying magmas. This well-known principle is lost sight of by Professor Daly. Apparently the author's units for classification have been petrographical names and definitions, and not the rocks themselves, with which he seems to be less familiar.

Having qualified the Qualitative System of Rosenbusch to suit his conceptions of it, the author proceeds in the third chapter to employ it quantitatively, and undertakes to determine the relative abundance of various groups of names which he has called "clans," assuming that the areal distribution of igneous rocks, as represented on maps made at various times by many geologists and petrographers, will furnish a reliable basis for the comparison of actual rock bodies and of the relative amounts of various kinds of igneous rocks! To one familiar with the methods of geological cartography, with methods of observation and petrographical determination of large areas of igneous rocks, and also with the modes of occurrence of rocks in the field, the idea of employing the areal representations of such bodies as a means of estimating the relative quantities of rocks grouped by Professor Daly into "clans" is remarkable both as an evidence of the author's respect for the data before him and as an indication of his conception of the structural geology involved. Great areas of igneous rocks are commonly so complex that their mapping is not attempted in detail on many maps, and in some regions a thin surface flow of lava may overlie hundreds of square miles of other igneous rocks, which is the case in eastern Idaho, for example, where basalt overlies rhyolites which are not represented on maps of the region. The value of his efforts to determine the relative quantities of various kinds of igneous rocks, as well as of the classification he has applied to the rock bodies studied, appears in his conclusion that the rocks of the globe belong quantitatively to two types, "granite" and "basalt"; a statement which shows that his petrography goes back to that early period when "granites" and "greenstones" were considered to be the chief groups.

In shutting his eyes to the great volumes of intermediate rocks which form the chief bulk of igneous magmas Professor Daly exhibits the results of the method which controls his researches, and also to what extent an observer may "feel the pressure of the category" (p. 62). It goes without saying that the writer disagrees with Professor Daly as to the value of the observer under such circumstances. The lack of breadth in his discussions of some subjects is shown by his failure to give proper weight to the effects of erosion in revealing the deeper-seated intrusions of older times, as well as in removing older surface lavas, which accounts for the apparent differences he finds in the modes of eruption of magmas in different geological periods.

The chapters on intrusive and extrusive rock bodies are full of excellent diagrams and illustrations of many instances which have been taken from many sources, as the author states, and they contain a great deal of valuable material. However, with his opinions regarding batholiths the writer takes many exceptions which have been expressed in the lectures on volcanism already referred to. It is to be regretted that in his discussion of these bodies Professor Daly is constantly confounding observed facts with hypotheses to the serious confusion of the reader. His suggestion as to the origin of the rhyolite plateaux of the Yellowstone National Park, which is expressed diagrammatically in Fig. 71, shows the limits to which he is willing to be led by his speculations, and becomes a *reductio ad absurdum* for his batholithic hypothesis, of which he says it is a logical outcome, when one considers the geological structure of the region and the character of the rhyolite lava flows

forming the plateaux. The diagram referred to would seem to be a limiting case of the author's indifference to rational geodynamics, yet in the introduction to Part II. he states that "Throughout the preceding chapters the attempt has been made to admit only such descriptions and classifications as are direct expressions of objective facts."

The second part of the book begins with a discussion of the possible temperature and constitution of the earth, which he concludes consists superficially of an outer "acid" or "granitic" shell with a partial covering of stratified rocks, underlaid by a liquid "basaltic" shell. He states that the phenomena of intrusion and of rock variation can all be explained by the interaction of these shells, to demonstrate which the succeeding chapters were written. The hypothesis of concentric zones of granitic and basaltic magmas is like those of von Waltershausen, Durocher and others, and the synthetic features are similar to those of von Cotta. These hypotheses were evolved before the closer study of igneous rocks had shown the error of their fundamental conceptions. This modern knowledge Professor Daly ignores, and any attempt to convince him of his mistake would involve a course of instruction which he does not appear to desire. It is not too much to say that the statements he makes in support of his hypotheses regarding the constitution of the lithosphere, the processes of magmatic intrusion, of overhead stoping, assimilation and subsequent differentiation appear to the writer to be in part fundamentally wrong and in many cases thoroughly misleading to the reader. It would be an extensive undertaking to criticize his elaborate and voluminous arguments in detail, and it would be a task the writer does not care to attempt.

His discussion of "abyssal injection" which is based on the assumption that the earth consists of a "relatively thin crust overlying a fluid basaltic substratum of unknown thickness" (p. 192), and the diagrams illustrating his conception of the process, as well as of that of batholithic intrusion, and also the scheme of rock genesis which is given in Part III., are all based on the principle of contrasting two assumed antithetical qualities, or groups of properties, such as a "solid crust" and a "liquid substratum," an "acid" rock mass and a "basic" rock magma; corresponding to the two magma hypothesis of Bunsen with its synthetic corollaries. It is a system which does not appear to be in harmony with modern notions of evolution, but finds its counterpart in metaphysics, with its antithetical right and wrong. It seems to the writer that physics, not metaphysics, should furnish the basis for modern petrology.

In calling his speculations an "Eclectic" theory Professor Daly has not distinguished it from any other complex theory of the present day, which in the nature of science must be derived from many other theories or hypotheses, previously enunciated. All modern complex theories are eclectic, or are but slight modifications of previous ones. The theory to which that of Professor Daly is most closely related, as he points out, is that of Loewinson-Lessing, published fifteen years ago, which its author called a "synthetic-liquation theory of differentiation," a name which has the merit of being descriptive.

The third part of the book before us outlines the result of applying the author's theory to the problem of petrogenesis. The result is a most remarkable distortion of petrographic relationships, and a thoroughly artificial scheme. The grotesqueness of the conclusions might be relied on to condemn the process of reasoning by which they have been attained were it not for the eminence of the author, the magnetism of his personality, and the effectiveness of his address, which give a seriousness and force to his writings that will carry conviction to many readers who have no means of independent judgment, both as to the correctness of his direct statements in each case and as to which are realities and which subjective conceptions.

With Professor Daly's tireless energy and vigorous methods of attack; with the acknowledged honesty of his conviction as to the correctness of his reasoning, but with his lack of discrimination between the relative values of objective realities and subjective conceptions;

with his chivalrous devotion to a "complete mental system," and with his courage in the use of his speculative imagination—he is a veritable knight errant in petrology.

J. P. IDDINGS

BATAVIA, JAVA,
August 3, 1914

Bacteria in Relation to Plant Diseases. By ERWIN F. SMITH, in charge of Laboratory of Plant Pathology, Bureau of Plant Industry, U. S. Department of Agriculture. Volume three. Vascular Diseases (Continued). Washington, D. C. Published by the Carnegie Institution of Washington, 1914. Quarto, viii + 309 pp.

It is not so many years since we were assured by some foreign bacteriologists that bacteria did not and could not produce diseases of plants. Less than a dozen years ago the writer of this review took part in an impromptu discussion in the bacteriological laboratory of one of the German universities in which it was vehemently contended on the one side that American bacteriologists showed their incompetence by thinking that the bacteria they found in plants had any pathological significance. Even pear blight was held to be due to some other than bacterial action. The sweeping assertion was made that no plant diseases whatever were due to the presence of bacteria.

The three stately volumes which Dr. Smith has already issued remind one of these recent opinions, and one wonders what can now be said by these same disbelievers in the pathogenic relation of bacteria to the diseases of plants. At any rate, Dr. Smith has here marshaled an array of facts that must be staggering to one who still feels that bacteria do not cause plant diseases.

The present volume deals about equally with diseases of monocotyledons and dicotyledons, principally with diseases of sugar-cane and maize, and with those of potato, tomato and tobacco. A full account is given of Stewart's disease of sweet corn and all the evidence going to show that it is disseminated on the seed. The morphology and cultural characters of *Bacterium solanacearum* which produces the "Brown Rot" of potatoes and other related plants are given in full. The destructive tomato disease, due to *Aplanobacter michiganense,* is also illustrated and distinguished from that due to *Bacterium solanacearum.* Growers of tobacco will find a separate chapter on the bacterial wilts of tobacco.

Throughout the book are found more than 150 text illustrations, and 47 full-page plates, some of the latter colored. The reader will share the author's satisfaction with the way that the printer has been able by the use of excellent paper and ink, and carefully selected type, to bring out the text and the illustrations. In passing it should be noted that only twenty-nine of the illustrations are borrowed from other authors, so that in this regard also this book is a contribution to the literature of plant pathology.

Although this volume was issued in the early part of August, 1914, it is known that the manuscript left the author's hands about two years earlier. During its slow progress through the printer's hands Dr. Smith has added many a paragraph and illustration, so that in fact the volume has been brought down as close as possible to its date of issue.

We need only pause a moment to call attention to the admirable index, which is all that an index should be. It is first of all an alphabetical index of the topics treated and the terms used, but, in addition, these are so systematically arranged that the index is a conspectus of the whole volume, and especially of its various sections.

As the writer of this review runs over this volume and its predecessors he is still more impressed with the feeling that some of these days the botanists of this country must ask very emphatically for a text-book on plant diseases prepared by Dr. Smith. A text-book from his hand could do much to place plant pathology on a truly scientific basis.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

The Bacteriological Examination of Food and Water. By W. G. SAVAGE. Cambridge, England, University Press.

Dr. Savage has prepared this volume of 170 pages as "a practical manual" dealing with the bacteriology of water, milk and other food products and air. It begins with two introductory chapters dealing in particular with the significance of colon bacilli, streptococci and anaerobic spore formers as "indicator organisms." Then follow chapters on Water, Soil and Sewage, Shellfish, Milk, Modified Milk and Milk Products, Bacteriology of Meat and Meat Products, Air and the Determination of Antiseptic and Germicidal Power.

A book of this size covering so wide a field can not from the nature of the case give a complete and authoritative treatment of the various subjects under discussion—such a treatment for example, as Dr. Savage has given to the problems of water bacteriology in his excellent "Bacteriological Examination of Water." On the other hand the discussion seems somewhat too discursive and the procedures and standards of interpretation are stated with insufficient clearness and definiteness to make the book altogether satisfactory as a student's text-book or a practical manual for the laboratory worker. Dr. Savage does, however, give an excellent summary of recent English discussions in regard to the subjects treated, with a good list of reference to original sources which will make the book valuable for advanced students.

From an American standpoint the most serious defect in this work is the almost complete lack of acquaintance with the progress which has been made along these lines on this side of the water. It seems strange, indeed, to find a book on the bacteriology of milk, water, air and food with no reference to American investigations on the direct microscopic examination of milk, on the lactose bile presumptive test, on the bacteriology of sewer air and on the bacteriological examination of shellfish.

C.-E. A. Winslow

The American Museum of Natural History

Molecular Physics. By James Arnold Crowther. Philadelphia, P. Blakiston's Son & Co.

This little book of 175 pages, though entitled "Molecular Physics," contains in reality only such material as is usually found classified under the general head "Electronics." It represents an attempt to present in elementary, almost in popular, form the recent developments in physics which center around X-rays, the electrical phenomena observable in exhausted tubes and radioactivity. The author is himself Fellow of St. John's College and demonstrator in physics at the Cavendish Laboratory. The points of view taken are then those which have grown up in that inspiring atmosphere out of which have unquestionably come more of the influences which have molded modern physics than from any other two places in the world combined. Freshness and originality of treatment are to be expected from such an author, and the expectation is not disappointed. The first two chapters deal with the determination of e/m and e, the third and fourth with the work on positive rays, J. J. Thomson's beautiful photographs being given especial attention. The fifth chapter gives the usual deductions found in a chapter on the nature and size of an electron. The sixth and seventh chapters are entitled the Chemistry of the Model Atom and the Atom in Vibration and represent the best elementary treatment I have seen of atomic models in relation to spectroscopy.

The eighth chapter presents just a touch of the conventional molecular physics in the discussion of Van der Waal's equation, but the last half of the chapter returns to the electron theory of metallic conduction. This subject is treated in the usual way, but unfortunately, I think, without any attempt to explain, or even to state the serious difficulties which the theory encounters. This is the one place in the book where the untrained reader will perhaps obtain a somewhat erroneous impression. The last chapter on the Atom in Dissolution is a very brief survey of the subject of radioactivity. Altogether the book is admirable and contains elements of interest for both the physicist and the general reader.

R. A. Millikan

SPECIAL ARTICLES

MILK EPIDEMICS OF SEPTIC SORE THROAT IN THE UNITED STATES AND THEIR RELATION TO STREPTOCOCCI

IN England epidemics of sore throat, bearing some relation to the milk supply, were recognized as early as 1880 (Rugby). Since then a number of such epidemics have occurred and in those in which the etiology was investigated, streptococci were uniformly found as the infectious agent. In some of these epidemics there were reasons to believe that udder or teat infections were the source of the organisms; in others the evidence seemed to point to a milker or handler as the source.

In the United States the first epidemic of sore throat recognized as having a definite relation to the milk supply appeared in Boston in 1911 and was carefully investigated by Winslow.[1] There is no doubt, I think, that many such epidemics have occurred in the past in this country, as well as in other countries, but on account of the almost universal prevalence of ordinary colds and sore throats their epidemic character and origin was not recognized. Indeed, in the medical literature there are references here and there to outbreaks of severe colds and other similar infections associated with serious and fatal complications, such as peritonitis. It is not unlikely that such epidemics originated from a contaminated milk supply since we know that these milk epidemics are, as a rule, serious infections followed often by severe complications. In the case of milk epidemics of scarlet fever, diphtheria and typhoid fever, it may be pointed out that formerly their possible relation to the milk supply was not recognized or was denied, and only recently, when more intensive studies of such epidemics were made, was their true relation to milk supply established.

Since the Boston epidemic of 1911, similar outbreaks have been reported from Chicago, Baltimore, Boston (1912), Concord, N. H., Cortland and Homer (N. Y.), Wakefield and Stoneham (New York) and Jacksonville, Ill. The number of persons stricken in these various epidemics has been estimated as follows: Boston, 1,400, Chicago 10,000, Baltimore 1,000, Boston (1912) 227, Concord 1,000, Wakefield and Stoneham 1,000, Cortland and Homer 669, Jacksonville 348; making a total of nearly 16,000. Probably many more than this number were affected since the above are all conservative estimates. This number is sufficient to at least give one some idea of the magnitude and importance of this type of infection.

In all, the onset, the character of the symptoms, and the later complications are strikingly alike and, it may be said, they agree in this respect with the epidemics in England. Furthermore, the relation to the milk supply appears to be unquestionable in all. The interesting fact stands out that there is a certain uniformity in the reports in that the contaminated milk, though used perhaps by a small proportion of the people, still furnished a very high proportion (70, 80 or 90 per cent.) of the reported cases. The remainder of the cases probably resulted from personal contact or from some other means.

Streptococci were unquestionably the cause of the disease in all the epidemics, being found abundantly in the throats or in the secretions of the sick persons in all the cases investigated. This fact is of great importance because it establishes definitely the etiology, and since the clinical symptoms in all the epidemics are so strikingly uniform, we may consider these infections as a definite clinical entity. They should, I think, take their place and be considered in text-books in medicine along with other infectious diseases, such as scarlet fever, measles, typhoid fever and the like.

As regards the nature of the streptococci, there is a fair degree of uniformity so far as the reports of the various investigators permit one to judge. They are all virulent, usually highly so, for animals. In general, they correspond, with only slight variations, in their morphology, in their cultural characteristics, and in their biological properties. In certain respects there seem to be some

[1] *J. Inf. Dis.*, 1912, X., 73.

slight differences between these streptococci and the ordinary *Streptococcus pyogenes*, and these differences have been sufficient to lead to the use of the special term *Streptococcus epidemicus* for them. It should be stated that it may be questioned whether or not the differences between them and the *Streptococcus pyogenes* are sufficient to justify such a distinction. They may be simply highly virulent strains of ordinary *Streptococcus pyogenes* whose properties have been modified by animal passage.

In some of the reports, particularly the earlier ones, and this is especially true of the English epidemics, descriptions of the streptococci are not given in detail. In certain instances this could not be done because the epidemic was practically over before its study was undertaken. It is unfortunate that this is so, because it is very important that the organisms from each of these epidemics should be carefully studied in order that the results may be correlated. It may not be out of place here to call the attention of physicians and health officials to the importance of such studies. Especially should the local physicians and health officers in small communities and towns be on the lookout for such epidemics, for it is they who meet these cases early, the time most suitable naturally for the isolation and study of the causative agent. Such physicians and health officers should see to it therefore that a careful bacteriologic study be undertaken as soon as possible. If they have not the means at hand or for any reason do not care to undertake such a detailed study, they should send the material to some laboratory where this can be done. The writer would be glad to examine such organisms with a view to identification and requests any who may desire to do so to send such material to him.

It may be stated that in the future it is probable that the small community will be affected by such milk epidemics more frequently than the larger cities since the milk products are apt to be less carefully handled and pasteurization will less often be required than in larger places.

One of the properties noted in the streptococci from nearly all the epidemics is that of hemolyzing blood when the colonies are grown on human or rabbit blood agar plates. While there has been slight variations in the strains studied, they have been strikingly alike in this respect. By hemolysis is meant that a well-defined wide clear zone appears about the colonies in 24 hours at incubator temperature. It does not mean a slight halo occurring about the colonies nor does it mean a slight narrow ring of cleared media developing perhaps after 48 hours or more as occurs with certain strains of organisms. This property is of great importance because it is a very ready and practical means of differentiating such organisms from the common *Streptococcus lacticus* (*Bact. güntheri*) which are not hemolytic. These latter are practically always present in normal milk, and so far as we know are of no sanitary significance. It should be pointed out that there are other perhaps more reliable but less practical means of determining the hemolytic power of bacteria than the simple plate method. I refer to such methods as those of Lyall[2] and Marmorek[3] which should be used as confirmatory tests, where they are of real value.

It is not to be understood that every hemolytic streptococcus is necessarily virulent or dangerous to man. But finding them in any considerable number in milk should make one very suspicious of udder disease, and such milk should at once be excluded from use.

The question of the source of streptococci causing these epidemics of sore throat is an important one. Two possible sources are recognized: the one bovine—the udder or teats of the cow; the other human—some lesion in the throats, hands, etc., of a milker or handler. It is often a difficult matter to absolutely prove in a given case whether or not the infection is bovine or human in origin. This is because practically identical hemolytic streptococci occur in the diseased udders of cows and also in the throats and on the hands of milk handlers. Furthermore, both streptococcal infections of udders in cows and streptococcal

[2] *Jour. Med. Research*, 1914, XXX., 487.
[3] *Ann. de l'Inst. Past.*, 1902, XVI., 172.

infections in the human are relatively common; consequently, in an investigation of large numbers of cows and of milk handlers, as it is usually necessary to do in studying these epidemics, one is very apt to find instances of one or the other and hence draw conclusions accordingly. On the other hand, the real source of streptococci may be overlooked on account of some hidden focus of infection in the throat or tonsils of a milker which could not be detected in an ordinary throat examination. Or a cow might be suffering with inflammation of the udder and discharging millions of streptococci in the milk and still, as the writer has shown experimentally, the udder may show no physical signs of disease and might thereby escape detection on inspection. For these reasons it is readily seen how one might be misled in his conclusions when looking for the ultimate source of streptococci causing an epidemic.

In the Boston epidemic the source of the streptococci was not clear, Winslow stating that it was probably a carrier. In the Chicago epidemic, certain facts suggest that the origin was bovine, but absolute proof was lacking. Stokes and Hatchell from their investigations of the Baltimore outbreak "feel reasonably sure the infection was caused by streptococci of the epidemicus type from cases of mastitis among the herds supplying the dairy."[4] In the report of the Concord, N. H., epidemic, made by Mann[5] no mention is made of a possible bovine source. There was evidently sufficient opportunity for contamination of the milk by human carriers on the farms supplying the milk. In the Wakefield and Stoneham (N. Y.) epidemic reported by Morse,[6] a very definite connection seemed to exist between the epidemic and a throat abscess in one of the milkers. In the report of the Cortland and Homer epidemic made by North, White and Avery, the statement is made that "two cows having inflamed udders in the herd of Dairy X were undoubtedly responsible for the epidemic of septic sore throat."[7] At Jacksonville, Ill., the epidemic, studied by Dr. J. A. Capps and the writer, was caused by hemolytic streptococci and from two cows supplying milk to Dairy X the same type of organisms were isolated. No suspicious human carriers could be found on the farms or among the milk handlers.

From the above it is seen that bovine and human sources are suspicious, and perhaps each or both at times may be responsible. It is known that human streptococci may be highly virulent for cows[8] and the reverse may also very probably be true. In an analysis of milk organisms, therefore, the fact that hemolytic streptococci have been the cause in probably all the sore throat epidemics centers our attention at once upon this type of streptococcus. As yet there is no evidence that other types have any sanitary significance whatever so far as sore throat or any other human disease is concerned. I therefore call attention to the fact that in any investigation of milk streptococci, whether from the standpoint of pure or applied bacteriology, the relation of the streptococci to hemolysis of blood should be carefully noted. It is well known, of course, that hemolysis may not be an absolutely stable property in any given strain. A strain may occasionally alter its power in this respect just as it may change its fermentative properties under certain conditions. For practical purposes, however, it is of very great value, as I believe every one who has occasion to work with pathogenic streptococci will admit. Furthermore, the fact that the hemolytic property can not be correlated with other properties such as those of fermentation does not detract from its value as a differentiating feature, but rather adds to it.

The question of pasteurization is an interesting one in relation to these infections. In the case of at least four of the epidemics in this country the infected milk had been pasteurized by the "flash" method and the evidence in all indicated quite clearly that the milk was contaminated before pasteurization. Nothing further need be said, therefore, con-

[4] Public Health Reports, 1912, Vol. 27, p. 1923.

[5] *Jour. of Inf. Dis.*, 1913, 12, 481.

[6] *Am. Jour. Pub. Health*, 1914, 4, 506.

[7] *Jour. Inf. Disease*, 1914, 14, p. 132.

[8] Davis, *Jour. Inf. Dis.*, 1914, 15, 135.

cerning the absolute inefficiency of the "flash" method. The harm it may do by giving the people a sense of false security is also self-evident. In the remaining epidemics the milk was consumed raw. It would seem that our only safeguard against such epidemics is efficient pasteurization not only of the milk and cream, but also of the material entering into the manufacture of other milk products. It is a point of some importance that it is not uncommon for firms to sell pasteurized milk, but to sell cream in the raw state. The latter of course may be even more dangerous than milk.

The question as to what constitutes efficient pasteurization for streptococci is one that evidently requires further study. It is commonly stated in the literature that pathogenic streptococci are killed at relatively low temperatures (52°–54° C. for 10 minutes Sternberg). Undoubtedly for many strains this is altogether too low. The recent work of Ayers and Johnson[9] indicates that the thermal death point of typical streptococci varies considerably and one of 22 strains studied by them resisted heating for 30 minutes at 62.8° C. (145° F.), the usual temperature for pasteurizing. Furthermore, their viability in milk and milk products should be carefully studied since we know the media may exert an important effect on the resistance of organisms to heat. The pasteurization process may therefore have to be modified accordingly to meet these demands.

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[9] *Jour. of Agricultural Research*, 1914, 2, p. 321.

THE ARTIFICIAL FERTILIZATION OF QUEEN BEES

In July last, the senior writer called the attention of the junior writer to the desirability of attempting some work in bee culture, with the object of securing pure-bred queens. One of the lines of work decided upon was that of artificial fertilization of queens. In spite of the lateness of the season, it seemed advisable to begin work at once and eight newly emerged queens were secured before the end of the queen-producing season.

In six of the experiments, we suffered failures from natural causes; robber bees killed three and the workers refused to accept three. In a seventh case, the queen died as a result of an infection probably set up at the time of fertilization.

In an eighth experiment, apparent success seems to have followed artificial fertilization, and whatever the nature of this may be, it seems of sufficient interest to be recorded, awaiting, in the meantime, the next season for further attemps at confirmation. This queen emerged from her cell on July 23, 1914. Both wings were so rudimentary as to be almost unnoticeable. She was kept in a 3-frame nucleus, in which no drones were present and with a queen excluder applied to the entrance. On July 28, the seminal vesicles and spermatophore of a drone, which was captured in flight near one of the hives, were dissected out, teased apart, and contents diluted to facilitate manipulation. The fluid containing spermatozoa was then carefully injected through the genital opening of the queen. After this was done she was replaced in a queenless and droneless nucleus with queen-excluder applied to the hive.

By August 4, the ovaries showed considerable development, as indicated by the size of the abdomen, and on August 18 she began to deposit eggs, continuing to do so up to the time of writing, although normal queens had ceased to lay eggs for about a month. This was due probably to the stimulation given this swarm by feeding. To date, at least 3,000 eggs have been laid. The remarkable thing is that all the eggs have produced worker bees except four, which produced drones. In every respect the brood, capping of the cells, and the resulting worker bees are perfectly normal.

At present, the swarm is being strengthened and prepared for winter, so that studies of this remarkable queen may be continued next season.

Francois Jager,
C. W. Howard
Agricultural Experiment Station,
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SCIENCE

FRIDAY, NOVEMBER 20, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE MATHEMATICIAN IN MODERN PHYSICS[1]

IT is perhaps presumptuous for an experimental physicist to address a body of mathematicians. He can at best appeal. They are the arbiters of his science. They determine the number of cubic feet allotted for his antics. In a genial mood, they may give him the equivalent number of cubic centimeters. Physicists appreciate the clemency. Let nobody contend that there are, *necessarily*, laws of nature. In science, as in civil law, the experts in a measure make the facts. So I appeal to the law-givers of physics, with a purpose of exhibiting something of the method with which they have supposedly treated me, in the past forty years of my experience. If I am obtrusively personal I must be pardoned, for this is the only experience I have to give.

We, the experimentalists, are supposed to be the artists of science, a type of men who reach conclusions by intuition, by a happy leap in the dark. The inventor, the laboratory hermit, parades an essentially feminine type of mind, whereas the eternal masculine, the essentially logical trenchency, belongs to the mathematician. In all humility, however, in the dark recesses of the laboratory, there are skeptics who believe that both the physicist and the mathematician, in the main, follow the method of trial and error; that both develop from idea to idea. The usual outcome in the mathematical case is a huge paper basket, overflowing and standing in the waste; the outcome in the other, a sort of dismal morgue, a junk-shop of botches. Failures have been the rule, successes the exception. But as we flaunt our successes (and they only

[1] From an address given at the dinner of the American Mathematical Society, in Providence, September, 1914, on the occasion of the one hundred and fiftieth anniversary of Brown University, by Professor Carl Barus.

can be indefinitely manifolded, like truth) while our failures are still-born, we are known not for what we are or actually do, but by the occasional incident, by the happy accident. And it is this incident that wills it that the results of the mathematician are much more glorious, soaring unfettered and free even into transcendental space, whereas the results of the physicist, as a rule, must be of the earth, earthy. While the mathematician indulges an oriental dream—"Nein, Wir sind Dichter!" cries Kroneker—the physicist must tread the straight and narrow path, guided by the arithmetic of the fathers. We are the Puritans, you the unmitigated voluptuaries.

Judge, therefore, the astonishment of the world that it was left to our brother of the soil to detect the four-dimensional world among the inadequacies, or shall I say the débris, of the three-dimensional. It is the journeyman of science that clamors for a wider scope. It is rule of thumb evidence that cries exultingly "we are living in a Copernican era." Things believed to be at rest are asserted to be moving and so uncannily moving, that if there were an Inquisition in power to-day, we should all, like Galileo, be put to the torture. Need we then blame the physicist if in his intoxication he suspects that the mathematicians may not, after all, be the only experts, that the laws of his undoing may have been, in a measure, of his own making?

However, I am digressing too far. I will, therefore, reconsign the experimental skeptic to the allurements of his workshop and there he may grumble as he chooses.

I implied that it is suspected that the mathematician makes our laws for us. It is thus necessary to indicate, however superficially, what I mean. When I began my work in Germany in 1876 the theory of Weber, "Das electrodynamische Grundgesetz" of 1846, was rife in that country and had even invaded France (*cf.* Briot, Thermodynamique) and the other countries of continental Europe. Electrodynamics through the genius of Ampère (1821–22), had already definitely captured magnetism. Weber embraced the whole of electromagnetics in a single equation, consistent with the law of the conservation of energy. It was a beautiful theory; but it was action at a distance gone mad. Such indeed was the rage of these theories at the time that even Gauss and Riemann did not escape temptation, while Clausius revised and modified the argument throughout, bringing out a new theory of his own. I doubt whether any one here has read that theory. I have never seen it referred to and yet it is a superb piece of vigorous mathematical reasoning, quite worthy of Clausius.

I am induced to pause for a moment to speak of Weber himself, a singularly lovable child-like man, to all appearances hopelessly unpractical, so much so, that many of his intimates were wont to poke fun at him. But Weber, like his friend Gauss, was a profound mathematical thinker and in that capacity introduced two of the most practical things which the practical world has inherited; for the electric telegraph is a Gauss-Weber invention (1833); and what we now call our C.G.S. system of units is fundamentally the creation of Weber (1852) again following Gauss (1832). A man may, therefore, be practical even if he sometimes fails to drive a nail straight.

To resume: what these men did was to postulate a force which depended upon the states or motion of the point where force originates; but any phase of the force hammers away at any distant point co-temporaneously with the time of its origin. These electrical forces, in other words, did what gravitational forces still persist in doing. If we glance back at such theories from our present point of vantage, we can not but marvel how perilously near they came to the state of the case as we know it to-day. If they had only retarded their potentials! It is all the more curious that they suspected nothing, as the 3×10^{10} velocity which characterizes the relation of Weber's electrostatic to his electromagnetic system of units, measured by Weber and Kohlrausch in 1856, is the velocity of light.

The respite accorded to any of these theories was brief. In England they were vigorously

condemned. Thomson and Tate, T and T', as we used to call them, in the earlier edition of their book anathematized them, as all the more pernicious in proportion as they were beautiful. They were completely swept away by the profound originality and incisiveness of the Faraday-Maxwell hypothesis (1854). Maxwell's great book (1873) had in fact appeared three years before I entered as a student, but it naturally was looked at askance in Germany, Helmholtz alone excepted. The aim of the earlier thinkers, to reduce the whole of electrical science to one equation was now to be realized in a way that marks one of the most important epochs in the history of physical science; an epoch comparable only to that of Newton; for although Maxwell modestly ascribes the incentive to his great accomplishments to Faraday, and believes that he is seeing nature with a mathematically unsophisticated eye, the capital discovery of the equations of the electromagnetic field (and this is the real issue) is Maxwell's creation. More than the widest sweep of the generalizing fancy could have anticipated was here completed; for at a single stroke of the wand, as it were, the whole domain of light and heat was annexed to electricity. It interpreted the meaning of the transparent and the opaque body of reflection and refraction. It introduced a new cosmical force, the light pressure long after found by Lebedew (1900), and our own countrymen, Nichols and Hull. It harmonized the divergent views of Fresnel and Neumann, admitting both impartially, and it gave to optics a new lease of life by lifting it over the obstructions of the elastic theory. Indeed Maxwell's best friends were apprehensive, since the theory predicted even more than was believed to exist, until in 1877 the new Maxwellian light dawned upon the mind of Hertz. The theory endowed the world medium, the ether, with new potencies, in insisting on its continuity, on the point to point transfer of electric force, so that ether stress became one of its familiar images, a veritable charm to conjure by.

It would carry us too far if we attempted to analyze the reaction of the new views on kindred sciences. Hydrodynamics, which had suggested the useful conception of the force-flux, in particular, profited and such beautiful researches as those of the Bjerknes (1863 *et seq.*) father and son, were stimulated in proportion as they fitted into the electromagnetic scheme. It was inevitable, moreover, that in the further treatment of Maxwell's equation the use of vector methods of computation should become indispensable in physics. They were approached cautiously enough and at first rather regarded as an affectation. Maxwell himself merely indicated the use of quaternian methods. Helmholtz, so far as I know, made no use of them. But in spite of petty differences of notation which still persist, the vector method became more and more general until to-day it is a commonplace, and beginning to make room for the new and more powerful 4, 6 and 9 dimensional geometry of higher vectors.

This was the second epoch and an epoch of unexampled fruitfulness. The ether electrically ignored heretofore has become all embracing. Woe to him that lisps, action at a distance! That Maxwell should have died before the ultimate vindication of his theory on the part of Hertz or the appearance of important corollary of Poynting (1884) is one of the tragedies of science. Similarly Hertz was not to witness the spectacular development of radio-telegraphy which followed so soon after his death. Maxwell's theory, which according to Hertz means Maxwell's equations, thus includes the whole of physics, dynamics alone excepted, and the world equation has advanced another step. Maxwell indeed, following the established custom, endeavored to call dynamics to his aid; but here his questions were put to a silent sphinx, inasmuch as mechanics had no counsel to give. Naturally the theory so revolutionary gained headway but slowly on the continent of Europe and even in England, unfortunately, Kelvin and (I believe) Rayleigh long remained unconvinced. When therefore the theory was universally accepted, it was already ripe for the modification, which Hertz himself actually began.

The ether as Maxwell left it has two independent properties, specific inductive capacity and permeability, which may be regarded as associated in the velocity of the electromagnetic wave passing through it. But the equations apply only for a medium at rest or at least approximately at rest, to a quasi-stationary medium. It is fortunate that a very coarse approximation to rest suffices; otherwise the early workers would have lacked encouragement. The new epoch, now about to dawn, thus found its point of departure in the motion of electrical systems. It has been in the main an era of confusion and bewilderment and one was to learn the hopelessness of any fundamental proof in physics. Instead of subjecting physics to the arbitrament of dynamics, we see dynamics pleading at the gates of electrical science, when electricity, distraught within itself, has no fundamental interpretations to offer. The troubles begin with the study of the first-order effects of moving optical systems, in the researches of Fizeau (1851); they become grave in the famous experiment of Michelson (1881) where the effects to be observed are of the second order. The speed of the earth, regarded optically from axes fixed in the ether, is zero. The ether and the earth have no relative velocity. This is tantamount to a rejection of the ether. Judge the consternation! As Maxwell's equation contained no direct reference to the motion of the charged body, a first attempt as I have already intimated was made by Hertz (1890) to supply this deficiency; but it was not of permanent value. The real interpretative advance came from Lorentz, in 1892. Although he fully realized and had endeavored to explain away the Michelson difficulties, Lorentz none the less boldly put his coordinates in an absolutely fixed ether, penetrating all bodies, even the atoms. He then went back to the methods of Weber, but with this essential difference that he included the whole dictum of the Maxwellian electro-magnetics in his postulates. The peculiar feature of the ether, its permittance and permeability, were abolished and in their place appears the velocity and density of the electron, or charged particle. Electric fluid exists; magnetic fluid does not. Lorentz then showed with consummate skill that the equations of the classic electromagnetics of Maxwell could be retained, that both the scaler potential and the vector-potential would retain their original form, would be invariant, so to speak, if the time-variable were belated by the interval consumed by light in passing from the source to the point of application in question. The profound originality and power of this and the earlier Lorentz transformation would perhaps not have been detected so soon, but for the unexampled abundance of new resources accruing to experimental physics at this time. In 1892 Lenard had isolated the cathode ray; Röntgen in 1895 discovered the X-ray. As a sort of corollary of the X-ray came the Becquerel-ray in 1896; the radium of the Curies in 1897, soon to be interpreted as to radiation by Thomson and Rutherford. The year 1896 brought the Zeeman effect, virtually predicted by Lorentz. The year 1898 brought Thomson's electron. In these and similar researches, bodies moving with a speed approximating that of light (easily exceeding $c/10$) were for the first time in history, at the disposal of the investigator. The new bodies, showing an inertia or virtual mass depending in a pronounced way on their speed, made havoc with Newton's laws and swept the classic dynamics mercilessly out of the field, as an arbiter of world phenomena. Theories such as those of Lorentz, 1892, or of Larmor, 1894, were now the only refuge. What could they do, was the ardent question, to replace dynamics?

Following the suggestion of Lorentz that the moving system contracts in the direction of motion, or at least apparently contracts to the fixed witness, Einstein in 1905 was the first to clearly perceive the iron logic of the situation; and the logic of a desperate situation is all there is in the theory of relativity. Einstein saw that if systems were to be interconsistent, time periods in the moving system would have to expand in the same second-order ratio to the ken of the fixed observer, so that time specifications and time frequencies may proportionately contract; or

that identical clocks in the moving system must go slower. In such a case, any natural phenomenon, preferably a vacuum phenomenon like the velocity of light, is the same in all systems, moving or at rest. One system is as good as another. All observation is relative. The equations of this celebrated principle of relativity, culminating in Einstein's famous addition theorem of velocities belonging to different systems—an ultimate break with the Galileo transformation, where time has the same absolute value everywhere—have been the very focus of discussion for the last ten years.

In its original form, the principle is as yet rather a detached statement, adapted to definite purposes but lacking in mathematical elegance. It was left to the genius of Minkowski (1908) to mould this flotsam of ideas into a philosophical system of extraordinary symmetry and breadth, the promise of which it is, as yet, too soon to adequately appreciate. In fact, the untimely death of Minkowski was an irreparable loss to science, even if with Hilbert we resignedly conclude to be grateful for what he has done for us. Minkowski's world, as he himself remarks, is a response of modern mathematical culture to the urgent demands of the laboratory, and therein lies its strength. In the minds of prominent thinkers it is a philosophical revolution, an inversion of thought, as far-reaching in scope as the similar revolution of Copernicus. "Let space and time be submerged," cries Minkowski in an impassioned utterance, "Sie sollen in den Schatten versinken," to make way for a single unified world; in other words, let the incantation ring in a world in which the variables x, y, z, t, are linked with ties as inherent and indissoluble as the variables x, y, z, in common space. So understood, every point in space, even if at rest, describes a world line, which may be referred to and is contained between the two extremities of the time axis. Uniform motion is a straight world line. Any other motion an appropriately curved world line. World time is the length of a world line in relation to the speed of light. These world lines are thus a veritable warp and woof of the Deity. With Goethe we may say "Sie weben der Gotheit ewig Gewand"—or recall the curious passage of Wagner's Parsifal "Du siehst mein Sohn, zum Raum wird hier die Zeit."

To establish the connection between the four variables which shall be invariant in case of linear time transformations as is the case in Newton's dynamics, or that shall embrace the Einstein transformations as a special case, Minkowski postulates a four-dimensional hyperboloid with a single parameter c, the velocity of light, given by the reciprocal of the time axis. The other parameters are one. The hyperboloid is now usually made equilateral by calling the time variable ct. The intersection of the xt-plane with this hyperboloid, thus cuts out two hyperbolas symmetrically above and below the x-axis, the former (for positive time) alone being considered. The major axis is again the reciprocal of c, the minor axis a unit.

Now if the hyperbola in question with its parameter c is referred to conjugate diameters, it is easily shown that the oblique time and x-axes imply all the transformations of the theory of relativity, for the same c. The equation of the hyperbola is an invariant with relation to the new axes. The axes, or units of measurement, are proportionately increased, the specifications or numerics decreased, but the ties of the variables are exactly the same as before. Minkowski calls this the group G_c. Velocities greater than c are imaginary and are thus essentially excluded.

On the other hand, if the parameter c be supposed to increase to infinity, the symmetrical hyperbola eventually coincides with the x-axis, eliminating the time axis, and referring the whole system back to Newton's dynamics. This is the transitional group G^{∞}.

The generalized time is then the new variable of which x, y, z and t are all functions. Every translational vector now has four components and the rotational vectors six components, corresponding to the six pairs of variables or planes of rotation. One may even add that the new world, like Cæsar's Gaul, is divided into three parts by the asymptotic

cones unknown to Cæsar. Axes may be so chosen as to make any two events contemporaneous. They need merely be parallel to the time axis selected. Similarly there are four equations of motion, the fourth being the energy equation, as energy itself is possessed of inertia. Finally, the equations of electromagnetic field in their magnetic and electric aspects, like the rotations, are given by the geometry of a vector with six components.

The treatment of motion is thus profoundly generalized, and Minkowski remarks that if these new transformations had been discovered by a mathematician "aus freier Phantasie," by an untrammeled imagination, they would have constituted a triumph in mathematics of the very first order. But, even under present circumstances, as soon as such developments were demanded by the laboratory, finding that within the atom the Newtonian world is certainly discredited, mathematics was at once ready to embody the new conception in a way that makes the bonds of mathematics and physics closer than before.

Vast and beautiful as these generalizations are, we must nevertheless confess that they are still but a coarse reproduction of nature; for in none of them is there any unequivocal or imperious demand for gravitation. Gravity still acts at a distance, as did the electrical vector in the days of Weber. Nor is the most generalized electromagnetic field able to account for the spectrum distribution of radiation, in the development of which energy threatens to pursue, if it has not already entered, the route of atomistic physics occupied by chemistry.

While mathematics is easily able to cope with the problems of relativity, even in their most generalized aspects, since they never break with continuity, the questions are more menacing in the second class of the recent demands of experimental physics, which came to a crisis in certain straightforward experiments on radiation made at the Reichsanstalt (Lummer and Pringshen, 1899; Christianson, 1884). The question dates back to Kirchoff's black body (1859), in which emission and absorption are equal. Some time after came Stefan's universal law of black body radiation (1879) and the theoretical verification on the part of Boltzmann in 1884. There was a period of intermission, in which the question of the equi-partition of the energy of a gas among the degrees of freedom of its molecules was vigorously discussed but without leading to available conclusions. However with the introduction of the black body by Kirchoff and the treatment of its radiation as a case of thermodynamic equilibrium, it was possible to assign both temperature and entropy to such radiation. But there was one further fundamental step to be taken and that was the definition of entropy apart from the Carnot engine and the intelligent manipulator, who is always an implied part of that wily machine. The second law was to be freed from reference to anything of a biological nature. Helmholtz had often insisted that the second law is the result of the order of physical size of the agent, in comparison with the atomic size, of his lack of equipment to control the individual molecule. To a being of molecular dimensions, there would be no irreversibility; whereas irreversibility has a very real meaning to the grosser attributes of the corrupter of nature. It was to the genius of Boltzmann (1877) that the fulfilment of this task was allotted. He was the first to give to entropy a purely mathematical signification, defining it as the logarithm of the probable occurrence of any thermo-dynamic state, be it a distribution of velocities, be it a definite distribution of discontinuous radiation energy-elements. Along this line, therefore, the new thermodynamics proceeded effectively. The first step came from W. Wien, whose displacement law of 1893 is embodied in the shift of the maximum of spectrum energy density, from red to violet, with increasing temperatures. Wien showed that a universal function of the ratio of temperature to frequency must here be in question. The determination of this universal function was the culmination of the insight and consistent labors of Planck (1900), who by postulating the energy quantum, became the creator of modern thermodynamics; for this energy element is a saucy reality, whose

purpose is to stay. It not only tells us all we know of the distribution of energy in the black body spectrum in its thermal relations, but it gives us, indirectly, perhaps the most accurate data at hand of the number of molecules per normal cubic centimeter of the gas, of the mean translational energy of its molecules, of the molecular mass, of the Boltzmann entropy constant, even of the charge of the electron or electric atom itself. Under the guidance of Nernst it has created new chapters in the treatment of specific heats at low temperatures, their evanescence at the absolute zero of temperatures, the evanescence of the specific electrical resistance at zero, all more or less bearing on Dulong and Petit's law. Not less vital is the introduction of the new universal constant hitherto not even suspected, the "Wirkungs quantum," an equivalent of the Hamiltonian integral of action. Here then is a departure from continuity postulated for energy, which will hereafter operate with definite finite elements only. The condition of occurrence of such elements in any definite relations, can for this reason be specified as a case of probability.

Of the Planck molecular oscillators I must speak briefly. If operating continuously under the established electromagnetic laws they lead to the impossible distributions of energy in the spectrum investigated by Rayleigh and Jeans. But if emitting only, when their energy content is a whole number of energy elements, a case thus involving the entropy probability of Boltzmann, Wien's law and the numerical data referred to are deducible with astounding precision.

This then is the peculiar state of physics to-day. The appearance at the very footlights of the stage, of a new constant, the meaning of which nobody knows, but whose importance is incontestable. Moreover energy is seen there under an entirely new rôle. Grasping at greater freedom she has hopelessly involved herself in the meshes of the doctrine of probability. There was a time, the time antedating Mayer (1840–42) and Joule (1843), Kelvin and Clausius, when to speak of indestructible energy would have been rash. It was a glorious epoch when she first appeared in the full dignity of her conservative and infinite continuity. In contrast with this, the energy of the present day is scarcely recognizable. Not only has she possessed herself of inertia, but with ever stronger insistence she is usurping the atomic structure once believed to be among the very insignia of matter. Contemporaneously, matter itself, the massive, the indestructible, endowed by Lavoisier with a sort of physical immortality, recedes ever more into the background among the shades of velocity and acceleration.

But the single equation of nature, aimed at by Lagrange and Hamilton, by Weber and Maxwell in their several ways, has nevertheless throughout all this turmoil reached a more profound significance and now even holds dynamics, awkwardly it is true but none the less inexorably, in its grasp. That it is not complete, that it never can be complete, is admitted (for the absolute truth poured into the vessel of the human mind would probably dissolve it); but that it is immeasurably more complete to-day than it was yesterday is as incontrovertably true as it is inspiring.

CARL BARUS

BROWN UNIVERSITY,
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CONTEMPORARY UNIVERSITY PROBLEMS[1]

THE story of Clark University during the quarter century of its existence, the close of which we celebrate to-day with the alumni, under the inspiring guidance of Dr. French and his committee, has in some respects no parallel in academic history. Especially the first few years of our annals have both brighter and darker pages than I can find in the records of any university. Thirteen of us instructors had taught or taken degrees at the Johns Hopkins, and we left that institution, which had added a new and higher story to the American university, when it was at the very apex of its prosperity and hence were naturally

[1] Address given on the occasion of the celebration of the twenty-fifth anniversary of Clark University by Dr. G. Stanley Hall, president of the university.

inspired with the ideal of taking the inevitable next step upward, as indeed were all the other members of our original faculty, which was remarkable, if not unpredecented in this country, in its quality. Of the no less notable original board of trustees, every member of which has now passed away (while death has not once invaded the ranks of our professorial corps), the triumvirate, Hoar, Devens and Washburn, who stood nearest to Mr. Clark, as his executive committee of all work, estimated the resources that were ultimately to be at our disposal at from eight to twelve million dollars, and very likely more.

I was at the outset sent on an eight months' trip to Europe, with several score letters of introduction, including one from the national government which gave me access to the inside workings of *Kultus Ministeria* and university circles and archives, so that my trip constituted a pedagogic journey I think almost without precedent. Twenty-five years ago these very weeks I was on this unique mission and was surprised to find the most eminent men of learning in Europe profoundly interested in it, and so lavish with their time, sympathy and counsel. I was entertained by Lord Kelvin, Pasteur, Helmholtz, Jowett, and some scores of others of the greatest living leaders in scientific thought; went on a trip of inspection of German universities as the guest of the Prussian Minister of Education, von Gosslar; perhaps most embarrassing of all, was taken in state by General Trepanoff on a visit to the two great Russian military schools near St. Petersburg, in each of which an all-day's program of military evolutions had been arranged for my special edification; was a guest of honor at a meeting of Swedish universities, etc. My instructions from Mr. Clark had been to see everything and every institution possible, collect building plans, budgets, administration methods of every kind, and find out a few of the best men who might be willing to come to a new institution here, but to engage no one, but to be ready to negotiate with them later. The amazement to me was how lavish everybody was of advice, how cherished and often how elaborate were the ideals of university men, many if not most of whom seemed to have imagined installations of their own departments rivaling not only Bacon's House of Solomon, but sometimes almost suggesting apocryphal vision. From my voluminous notes of that trip could be compiled ideals lofty, numerous and far-reaching enough to inspire all the universities of the world for a century, and to organize a new one here for the conduct of which ten times ten million dollars would be sadly inadequate.

They gave me plans of the then new four-million-dollar university building at Vienna, of the new Sorbonne at Paris, its rival, of the complete new university which Bismarck had established at Strassburg to show Alsace-Lorraine, which Germany had just annexed, and to show especially France, what the Teutons really meant by higher education, of the newly built university at Kiel, in which Germany sought to impress upon the Scandinavians the same object-lesson in her newly acquired Schleswig-Holstein, and which was designed to compete with the neighboring university of Copenhagen, just as she rehabilitated Koenigsburg to impress the same lesson upon the nearby Russian rival institution at Dorpat. I was given in some cases the secret *état* and the unprinted *Statuten* of the universities,—all this until I felt an almost Tarpeian embarrassment, especially as I was in nearly all these places utterly unknown and an object of interest solely because of my unique mission. I found young professors prone to see visions, and old ones to dream dreams, each for his own department, that all a king's ransom would be inadequate to make real. Of all this I wrote Mr. Clark and my colleagues here awaiting the great instauration. The harvest home-coming, with all these sheaves of suggestion and inspiration, marked the zenith of great expectation and of hope tiptoe on the mountain-top. For years and sometimes even yet, European savants who first heard of Worcester from me and have since known it only as the home of Clark University, seemed often, to our great embarrassment, to assume that many or most

of the ideals that we then discussed together are now realized in this golden land of promise, and rank us far above our own modest sense of our deserts.

If I came home slightly intoxicated with academic ideals, so were all of us in some degree, according to our temperament, but a reality that was sobering enough soon confronted us. I can not enter here upon the details of our disappointments, culminating in the tragic hegira to Chicago and elsewhere of three fifths of our faculty. If ever there was an academic tragedy, a *via crucis,* a veritable descent into Avernus, it was here. The story of these years has been carefully written out, with everybody heard from, and all the divergent interpretations of what occurred and what it meant faithfully set down, and filed away in our archives, and perhaps after another twenty-five years or yet another, it may be published.

Suffice it to say that although we started with far less than, justifiably or not, we had hoped for, we began the fourth year, 1893–94, with only about one fourth of the total annual resources that we had the first year. In the seven years that followed, down to the founder's death in 1900, we had for all purposes only four per cent. of the income of $600,000 plus that of $100,000 more for the library, that is, less than $30,000. Several of us who remained here were tempted by larger offers to what seemed more promising fields, but, on the whole, and I believe no one regrets it, we elected to stand by here. These lean years were, however, characterized by two features. First, they were years of unique harmony. There was no friction. We stood and worked shoulder to shoulder. And this is of prime importance in a small institution like this. In a great university discords can and always do occur, but here, where discontent in any department disturbs the whole institution, accord is one of the prime necessities. The other feature of these years was intense devotion to research and to teaching, and our productiveness, whether compared with our numbers or our income, has never been greater, and indeed, I wonder if that of any other institution has been greater relatively to its size. Perhaps the alumni of these days were, and will ever be, a little nearer to the center of the hearts of those who went through them, and it is significant, and can be no cause of jealousy to others, that it is they who are leading in the epoch-making activities that center about to-day and mark this as the date from which henceforth our alumni will be a potent factor in our future history. Their newly and well organized support, their enthusiasm for the spirit of research, which is our inspiration, will henceforth greatly reenforce all our best efforts here and be an inspiration to our future development.

With the dawn of the century came also the college, which has given us 51 students who have already taken degrees in the last eight years, although it has its own independent purpose. As to it, we are brethren, children of the same parent or, to change the figure, a married couple, and unlike married couples we can never be divorced, so that he who would make discord between us is an enemy to both, and every man who helps the other is a friend to both. Any encroachment of either upon the other's domain or any effort to profit or exalt the one at the other's expense, is bringing discord into sacred family relations. Our two-in-one or dual unity is unique, delicate, imposes new responsibilities and presents also inspiring possibilities for a new solution of some of the highest academic problems. I think we can truly say that each is now a noble stimulus to the other. We are proud of the college and we are so just in proportion as we know and understand its problems, aspirations and achievements. We are proud of the name and the work of its first great president and of the rare men he brought here, whose growth in knowledge and power, together with those of the college alumni whom they trained in his day, constitute his living monument, and we of the university salute the college colors in our decorations to-day, and hail with pride and give our heartiest Godspeed to the second president of the college, who is not only carrying out the ideals he inherited of a three years'

course of non-athletic and citizen-building functions, but is going further and making the college a leader and light among others in the land. Would that some one would offer a prize for some pregnant symbol, seal or even slogan or song typifying this unique conjunction, which college and university should forever unite to use! Could we not fitly commemorate this occasion by a new resolve that there shall never be tension or strain between us, and that a policy of mutual help shall henceforth animate us both?

In the recent voluminous literature on colleges, so much under discussion of late, we have several characterizations of the ideal college professor, and these agree pretty well. He must be a good man, a model citizen, a gentleman and a scholar, a teacher born, made or both, tactful, and in close personal relations with his students, anxious and able to teach them all they are capable of learning in his department, a man whose character will be normative and influential for good, fitting students, not for the university, nor even for professional or technical careers chiefly, but for their work in life in general, and evoking all their powers. Noble as are all these traits of nature and nurture, and rare as is their combination, and exacting as are the conditions of instruction and parental care, many college professors go further and are not even content with the useful work of making textbooks, but really add to the sum of human knowledge by their researches, and it is a satisfaction to us that so many of those here are with and of us in this respect.

For the university professor research is his prime function. He must specialize more sharply, must not only keep in constant and vital *rapport* with everything that every creative mind is doing in his field the world over, but he must hear and lay to heart every syllable that the muse of his department utters to every co-worker everywhere, and best of all, she must also speak new words through him. There is a vital sense in which he stands in closer relation to his co-workers in other lands than to his colleagues in the same institution. The chief momentum of the vital push-up in him impels him to penetrate ever a little farther into the unknown, to erect some kiosk in Kamchatka, where he can wrest some new secret from the sphinx, who has far more to reveal than all she has yet told. Whenever he grows impotent to do this, he becomes only an emeritus knight of the holy ghost of science. Studies of the age when men in various departments do their best work show that scientists are the oldest of all the creators of culture values on the average, but that there is more individual variation, so that they cross the dead line both older and younger than any others. It is one of the hardest things in the world to be and remain a productive investigator. There are so many journals and books to be read, so many and constant alterations and adaptations, needful to press the questions we ask nature home and to get an answer, such changes of methods and apparatus, so much that was yesterday new and will to-morrow be obsolete if we would not abandon what Janet calls "*la fonction du réelle*," and take some kind of flight from reality and its ever-pressing *devoir présent*. But if research is hard and the life it demands beset with dangers, so that many are always falling by the way without giving any sign of their demise to outsiders, this work has its supreme reward, and I can not believe that there is any joy life has to offer quite so great as the Eureka joy of a new discovery.

Not only this work itself, but its conditions are amazingly complex, unstable, and ever shifting. Just at present it seems to me that academic unrest was never quite so great the world over, and that the near future never promised so many important changes. Some abuses, great and small, have of late grown rank and demand remedy. Certain vicious tendencies must be corrected and reforms made. Bear with me if I ask you to glance briefly at a few of these.

Beginning with the Teutonic countries, since 1907 the assistant professors and docents have developed a strong inter-institutional organization against the head or full professors. The unprecedentedly rapid growth in the size

of the student body everywhere has resulted in what Eulenberg calls a lush "*Nachwuchs*" of assistants of all grades. Statistics show that on the average the *Extraordinarii* or assistant professors receive this appointment at the age of 37, at an average salary of $523, and remain in this position nearly 20 years, attaining an average salary of $1,200, before promotion, at the average age of 57. These now constitute, with the docents, about half the teaching personnel of German institutions, and they often have neither seat nor vote in the faculty and little participation in the corporate life of the institution. In the municipal university which opens at Frankfurt this fall it was even proposed to have a president of the American type, to safeguard the assistants against the oppression of the full professors. A few years ago Tübingen, and last year Zürich, radically revised their ancient statutes to remedy these evils, and the projected university at Hamburg will go yet further. The two new universities in Hungary, at Pressburg and Debreczen, and the private one at Hongkong—these grant more liberty and show more appreciation of the enthusiasm and ideals of the younger members of the faculty. Even students in Germany have caught the spirit of unrest, if not revolution, and now have a strong inter-institutional organization, and their pamphlets are boldly demanding better methods of teaching, printed outlines of professors' lectures, are trying to develop a sentiment that no instructor shall ever repeat in a lecture anything he has ever published; are calling for more options, especially more freedom of choice in the selection of subjects for their theses and more meaty topics for them that do not make their work ancillary to that of the professor, more personal rights to what they produce or discover in them, a longer period of *hospitieren* or of trying out each course before they finally sign for it, more and better seminaries with better tests for admission, more practical courses, better access to books, journals and library facilities generally, less overcrowding and more elimination all the way from *Ober-Sekunda* in the *Gymnasium* to the doctorate, better social opportunities, dormitories, more personal contact with the professors, less restrictions on their personal liberty, reform of the corps, honor system and the *Mensur*. This unrest, although it seems ominous to conservatism, can not fail to prevent waste and bring reform.

In the English universities agitation has had many recent expressions, from Lord Curzon's demand for reforms in 1909 on to Tillgard's of last year. Here the protestants grant that these institutions still breed the flower of national life, the English gentleman, but demand better library facilities than the individual colleges, with their wasteful duplication, afford, and especially more of what the critics so strenuously insist is still lacking and that parliament should enforce, namely, more teaching and research. Thus the deepening sense that something rather radical must be done seems now crystallizing into just what that something should be. In France and in Russia unrest is greater and reforms are more loudly demanded.

In this country academic unrest has been largely directed against organization and administration. In the old days the college president, though he usually taught, was supreme and autocratic, and as leading institutions grew and he ceased to teach, the concentration of power in his hands became altogether excessive. The foundation of new institutions, the Hopkins, and a little later Stanford and Chicago, greatly augmented his power under our system. He had to determine the departments, select professors, fix their status, build, organize, represent the institution to the board and public, perhaps the legislature, plunge into the mad, wasteful competition for students and money, lay supply pipes to every institution that could fit. Never was the presidential function so suddenly enlarged nor its power so great and uncontrolled as a decade or two ago. Even the University of Virginia and other southern universities, which had only a president of the faculty, elected by its members, fell into line, and a reaction toward democratization, which in its extreme form seemed sometimes

almost to adopt a slogan, "Delindus est prex," was inevitable. In the Cattell movement *abundant incidents of arrogance and arbitrary, if not usurped, power were collected, and it was even insisted that although charters* or conditions of bequests, to say nothing of American tradition, would have to be reversed, it was urged that the president should be only chairman of the faculty, elected perhaps annually by them, and in the literature of this movement we find occasionally the radical plea that some or all of the powers of the board should be turned over to the faculty, who should at least be given control of the annual budget. More lately the movement of protest here is against the autocracy of the dean, whom the president had created in his own image, and who sometimes exercises a power that he would never dare to do, and who in large institutions has constructed a mechanism of rules, methods, procedures, standards, which have almost come to monopolize the deliberations of the Association of American Universities, which fortunately can not prescribe or legislate for its individual members. University deans have often created rules which they themselves can suspend for individuals, and this has greatly augmented their power. It is they largely who have broken up knowledge into standardized units of hours, weeks, terms, credits, blocking every short cut for superior minds and making a bureaucracy which represses personal initiative and legitimate ambition. Just now perhaps we hear most remonstrance against head professors and statements that the assistant professors and younger instructors in their departments are entirely at their mercy, that they are burdened with the drudgery of drills, examinations, markings, all at small pay, while their chiefs take the credit, so that the best years of the best young men, who are the most precious asset of any institution, or even of civilization, are wasted. Indeed we have vivid pictures of the hardships which often crush out the ambitions of young aspirants for professorial honors and tend to make them, if they ever do arrive, parts of a machine with no ideals of what sacred academic freedom really means. Happily now the best sentiment of the best professors now organizing inter-institutionally to safeguard their own interests and *those of their institutions*, stands for a most wholesome and needed movement which is sure to prevail.

So far I submit to you and to my colleagues that Clark University, not through any wisdom or virtue of its president, although perhaps a little through the fact that he is a teacher and does not spend all his time in organizing, but owing to its small size, its unprecedented absence of rules, its utterly untrammeled academic freedom, is to-day in a position to lead and not to follow in the wake of this movement. No one here wants autocratic personal power, but we do all want the best attainable, whatever it is. Each department here is almost as independent and autonomous as if there were no other. We have no deans, few assistant professors, and so no tyranny of departmental heads, no complaints on the part of students, as in Germany, that we are not doing the best we can for them, so that this world-wide movement for academic reform we ought to consider as a great and new opportunity to us all, trustees and faculties, at this psychological moment to realize our own advantage, and to carefully look over our present system and see if we can not use this opportunity to begin the new quarter century with our lamps retrimmed and burning bright, and alert and profiting by every suggestion that the academic *Zeitgeist* is now murmuring like the Socratic daemon in our ears.

Let us, then, look our present situation and ourselves frankly in the face. With the indefatigable labors of Senator Hoar in securing a just and legal execution of Mr. Clark's difficult will, labors which some of his colleagues in the board thought almost justified us in calling him our second founder, with a board more active and interested in our affairs, external and internal, than ever before, as their cooperation in this commemoration typifies, with our funds better invested and yielding a trifle more than they have ever

done, with an admirable library, the creation, body and soul, of Dr. Wilson, who has the greatest genius of friendship of us all, with the reestablishment of the department of chemistry, which was dropped for a few years, with the increase of salaries, from time to time, as far as means permitted, inadequate though most of these still are compared with the increased cost of living; with more departments and professors and instructors—we seem to have entered upon a settled period of prosperity and growth that promises that the next quarter of a century will far transcend the past, and, now that all the perturbations of the first formative era are over, we can look forward with confidence that the university will go on in the general direction it has already so faithfully held to during its period of storm and stress, *in sæcula sæcularum.*

We have no greater distinction than that which has come from always preferring quality, attainment and ability to numbers, and that these standards may never be lowered is the most heartfelt wish and prayer of all of us. My greatest joy to-day is in the spontaneous testimonials of appreciation and loyalty of our alumni in leaving their work and coming here, at this most inconvenient season and sometimes from a great distance, and giving us or wording their cordial personal greeting and Godspeed, and even in contributing, not out of their abundance, for most of them are moderately paid professors like ourselves, but from a sense of gratitude and as a token of good will, to the fellowships which constitute our very greatest need.

Turning to the future, the changes we need here are largely but by no means wholly in harvesting what we sowed at the start and assiduously cultivated ever since, for which the time is now ripe. It would be preposterous to lay out our course now for another quarter century. We must always maintain keen orientation in an ever wider and more intricate field. To my mind there should always be a specialist here and in every institution in what might be called the higher pedagogy and in academic history, whose business it is to keep keenly alive to all that is doing in academic life the world over. Especially now, when these changes are so rapid, some one must spend much time in the outlook tower, and I would even hazard the strong opinion that, had foreign institutions had a specialist in the conning tower, intent on studying the ever changing signs of the times and trained in academic statesmanship, many, if not most, of the errors that have caused our own and foreign universities so much waste of energy in recent years, might have been avoided.

The time is at hand when university rectorates, presidencies, chancellorships, or whatever their name, can no longer be filled by any professor or even outsider who can secure election, but will require men who, whatever else they are or know, are experts in the history of the higher culture and its institutions, from the four great academies of antiquity down, who know the story of mediæval universities of the church and then of the state, of the guilds of scholars, the rise and present status of learned societies and academies, the great reforms of the past and the yet more significant reconstructions now evolving, the governmental patronage of learning and research, from the day of the Medici down to contemporary legislation for higher institutions, national and state, present-day centralization and the efforts against it in France, the many universities lately established by colonial policies, the world-wide movement of university extension. He must suggest ways and means to his colleagues for achieving their own even if unconscious ideals; help free investigators to be the supermen they are called to be, each in his own way, have a minimum of arbitrary authority and a maximum of faculty cooperation, catch and sympathetically respond to and find his chief inspiration in the fondest, highest, if secret, aspirations of each of his coworkers, who must not be content with the stale ways of the present perfervid competition for dollars and students or with the mere horizontal expansion, the multiplication of machinery or devices for efficiency of factory type, but study precedents, culture trends, and believe profoundly in the power of faculty

democratization and do his utmost to develop it, regardless of his own personal or official prestige or authority. On the continent, mayors are trained professional experts, and cities vie with each other competitively for their services and find they can well afford to do so, for their special training means vast economies. Universities in this country, if not the world over, are more nearly ready than are cities to profit by this example, and their gain thereby would be even greater. Twenty years ago Professor Paulsen, of Berlin, the best representative of the higher pedagogy I plead for which that country has yet produced, warned German universities of the very dangers which have now waxed so grave, and with which they are battling, and the presidents here have only too good reason to look either with jealousy or with hope, according to their temperaments, upon the now rapid addition of the higher story of academic pedagogy to the old schoolmaster's pedagogy of the grammar and high school, and development in this direction is another of the pregnant signs of the future.

Think of the changes since we began. Many special lines of research have their own institutions where little or no formal teaching is done, like astronomic observatories, the Rockefeller Institute, Wood's Hole, Cold Spring Harbor, the Carnegie Institution, with all the possibilities of his will, the question of a national university, always with us, just now of the Fess hundred-million-dollar type, to be devoted chiefly to research, the enormous expansion of teacher-training in nearly every higher institution of this country, a movement that is almost without precedent in its magnitude and suddenness, the augmented stress laid upon practical applications of pure science—these constitute a new environment, as also do the active and well-organized but silent field agencies of most large institutions both to recruit students, with competing agents at the ear of every boy who thinks of going on, and also to place their graduates in every academic vacancy. These are problems to which a presidential or other agency must give great and growing attention and for which the president of the future must have special training, and in which also the faculty must share the burdens of administrative responsibility since questions must often be decided one way or the other, while those who determine them are uncertain, themselves, so that criticism accumulates.

As to professors, the best of them make an almost unprecedented sacrifice and could have achieved the highest success in financial, professional, political (witness President Wilson) and other lines. They know the price they pay and are willing to pay it, but must have as their compensation the boon of security and liberty to teach and investigate freely what and how they will. The university professorate, too, means not only the cult of specialization but of individuality. Even idiosyncrasies are to be not only tolerated but respected and perhaps welcomed. The university should be the freest spot on earth, where human nature in its most variegated and acuminated types can blossom and bear fruit. The factory type of efficiency has no place there. Each must make himself as efficient as possible, but in his own way and independently of all external circumstances, and without the multiplication of machinery, so that an able organizer with nothing to do but to administer might prove an unmitigated curse to all the best things a professor and even a university stand for.

Thus now I, who with one tiny exception, have never, during all these twenty-five years, to a single citizen of Worcester hinted at a donation, will say a word which I wish all would hear and consider. We greatly need and shall always need more funds to strengthen existing and to found new departments. Though we bear another name, we are, fellow citizens, your University of Worcester. In all the spheres we touch, we have spread the name and added to the fame of this Heart of the Commonwealth. If we had ten million dollars more, not one of us would gain personally, but should only have more work, for we are only administering the highest of charities.

If you doubt that this is the highest, listen

to the conclusion of the report of the most elaborate parliamentary commission Great Britain ever knew, of forty volumes and nearly nineteen years in the making, covering all British charities of every kind, more than twenty thousand in all, which is: that of all objects of charity, the highest education has proven wisest, best, and most efficient of all, and that for two chief reasons, first because the superior integrity and ability of the trustees who consent to administer such funds, together with the intelligent appreciation of those aided by them, combine to furnish the best guarantee that they will be kept perpetually administered in the purpose and spirit of the founder whose name they bear; and second, because in improving higher education all other good causes are most effectually aided. Since the first endowment of research in the Greek academy, porch, grove and garden, from which all our higher institutions have sprung, thousands of spontaneous free will offerings have borne tangible witness to the sentiment so often and vividly taught by Plato, that in all the world there is no object more worthy of reverence, love and service, and none that it pays a civilization better to help to its fullest development than well-born, well-bred, gifted, trained young men who desire to be masters in an age when experts decide all things, for in them is the hope and the future leadership of the race, and to help them to more of the knowledge that is power is the highest service of one generation to the next. And how this has appealed to all ages! Oxford and Cambridge have 1,800 separate endowed fellowships and scholarships, to say nothing of the smaller exhibitions. Leipzig has 407 distinct funds, the oldest dating 1325, and wherever the higher academic life has flourished we find scores of memorials bearing the names of husbands, wives, parents, children, and providing for students of some special class, locality or establishing or benefiting some new department or line of investigation, theoretical or practical; and now that the *rapport* of business, government and all social and cultural institutions was never so close, all who give greatly and wisely, or who make or suggest bequests, have a new *noblesse oblige* to consider.

Cold facts and figures finally show a few things that I beg you all to ponder now. These are, that compared either with the size of our faculty, the number of departments, or our annual budget, we have fitted more men for higher degrees, seen more of them in academic chairs, where they are found in all the leading institutions of the land, including some dozen of presidencies, first and last, published more original contributions which seek to add to the sum of the world's knowledge, have a larger proportion of members of our faculty starred as of first rank in Cattell's census of the competent, had closer personal and often daily contact with students, and given more individual help outside of classes, had more academic freedom (for no one in our history has ever suffered in any way for his opinions), had more autonomy in our departments, each of which is a law to itself, had less rules and formalities of every kind, and had a president who was less president and more teacher, good or bad, spent less time in devising ways and means of seeking contributions from our friends here, advertised less and avoided all publicity more, until now, when I am, just for this one moment, throwing all our traditions of silence, modesty, absence of boasting about our work, to the winds. In these respects we exceed any of the other twenty-four institutions of the Association of American Universities.

This Clark University means, has stood for and will forever stand for, and this is why we all love and have put the best twenty-five years of our lives into her service and wish we all had another quarter of a century to serve her better. This is what brings you alumni back with your offerings, your loyalty and hearty good wishes. This is the university not made with hands, eternal in the world of science and learning. Clark University is not a structure, but it is a state of mind, for wherever these ideals reign Clark men are at home, and all who have them are our friends and brothers.

It is this ideal that sustained us in our darkest days and now lights up the future

with a new glow. Is there any joy of service to be compared with that of the investigator who has wrung a new secret from the heart of nature, listening when she has whispered a single syllable of truth unuttered before, who has been able to add a single stone to the great temple of learning, the noblest of all the structures ever reared by man? Is there any more religious calling than thus thinking God's thoughts after him, and proclaiming the gospel of truth to confirm faith, prevent illness, deepen self-knowledge and that of society, industry, give us mastery over the physical, chemical, biological energies that control the world, and develop mathematics, the language of all who think exactly, a language which all sciences tend to speak in proportion as they become complete? This is why research is religious and the knowledge gained in the laboratory to-day may set free energies that benefit the whole race to-morrow. Is not an institution devoted, heart and soul, to this sort of work, the best thing any community can have in its midst, and should it not be cherished as the heart of this "Heart of the Commonwealth"?

G. STANLEY HALL

CLARK UNIVERSITY

RUSSIAN VERSUS AMERICAN SEALING[1]

IN recent discussions of matters relating to the fur seals of the Pribilof Islands great stress has been laid in certain quarters upon the similarity between the recent crisis in the herd's condition and a crisis in which it found itself in 1834, during Russian control. Since 1896 pelagic sealing has been looked upon by the majority of those having to do with the herd as the sole cause of its decline. But in 1834 and prior to that time there was no pelagic sealing, only land sealing. The argument, has, therefore, been that land sealing was common to both crises and hence a probable cause of decline in one as well as in the other.

Land sealing as practised upon the islands since 1868, when the herd came into the possession of the United States, has consisted in the taking of the superfluous young male seals at or about the age of three years, the fur seal being polygamous and its handling being analogous to that of the commoner domestic animals. Pelagic sealing was an indiscriminate form of sealing, conducted in the open sea, while the animals were on their winter migration in the Pacific Ocean or on their summer feeding excursions in Bering Sea, both of which take them far from land. Investigations of the pelagic catch show conclusively that sixty-five to eighty-five per cent. of the animals taken have been gravid or nursing females, with which died their unborn or dependent young.

There can be no dispute regarding these two forms of sealing, as they have been conducted, at least since the beginning of pelagic sealing, about the year 1880; the records are exact and complete. The question therefore turns upon the nature of Russian sealing at and prior to 1834, of which the records are not so complete.

In the debates in congress upon the fur-seal law of 1912, in which land sealing was suspended, as a measure necessary for the protection and preservation of the herd, Senator Shively, of Indiana, made the principal speech in the Senate, taking as his thesis the assertion that the Russians never killed anything but bachelor seals. Representative Goodwin, of Arkansas, made the leading speech in the House and his thesis was that the Russians did not kill female seals. These speeches were alleged to have been based upon the official records of Russian operations. Their purpose was to show that the Russian sealing, which was followed by the disaster of 1834, was identical with that conducted on land by the United States in the disastrous period culminating in 1911, that is—confined to the bachelor seals or superfluous males.

Our knowledge of Russian conditions is derived exclusively from the writings of Bishop Ivan Veniaminof, a Greek-Russian priest, located for the period in question at Unalaska, and a brief extract from the report of an agent of the Russian government, Yanovsky

[1] Presented at the forty-fourth annual meeting of the American Fisheries Society in Washington, D. C., September 30–October 3, 1914.

by name, who made a special investigation of the seal herd in 1820. Bishop Veniaminof's account of the seals was published at St. Petersburg, in 1842, in a work known as the "Zapiski," and comprises pages 349 to 381 of volume 2 of that work. A partial translation of this article has been in existence for some time as an appendix to the fur-seal monograph of Henry W. Elliott, published in 1881, as part of the tenth census. Recently there has been made a complete and more accurate translation, by Professor Raphael Zon, of the U. S. Forest Service, which appears as an appendix to a report on the fur-seal herd by the writer to the U. S. Bureau of Fisheries for 1912, as yet unpublished. It is from this translation the quotations which are to follow are made.

The extract from the report of Yanovsky appears in a letter from the Board of Administration of the Russian-American Company, dated at St. Petersburg, March 15, 1821, and constitutes Letter 6 in the volume of facsimiles in the proceedings of the Paris Tribunal of Arbitration of 1893. A translation of the letter appears at page 58 of volume 2 of the same proceedings in an appendix to the case of the United States. This translation is paralleled by a British version at page 323 of volume 8 of the proceedings, being a part of the British counter case.

These translations of Yanovsky's report differ in one important particular and the essential part may be here reproduced in parallel columns for comparison. The translations are as follows:

American Version	*British Version*
Every year a greater number of young bachelor seals is being killed, while for propagation there remain only the females, sekatch, and half sekatch. Consequently only the old breeding animals remain, and if any of the young breeders are not killed by autumn, they are sure to be killed in the following spring.	Every year the young bachelor seals are killed, and only the cows, sekatch, and half sekatch are left to propagate the species; it follows that only the old seals are left, while if any of the bachelors remain alive in the autumn, they are sure to be killed the next spring.

The difference obviously lies in the use of word "bachelors" instead of "young breeders," in the British version. Accepting this translation the criticism of Yanovsky is that too many bachelor seals were being killed and hence the decline of the herd.

A study of the context, however, readily shows that the word translated "bachelors" in one case and "young breeders" in the other is contrasted with "old breeding animals" in the one case, "old seals" in the other. Internal evidence therefore favors the American translation—"young breeders." This translation is not in itself a logical one, since the animals under consideration are not "breeders" at all, but animals which have not yet attained breeding age. Mr. M. Lippitt Larkin, a Russian scholar, formerly instructor in Stanford University, in translating this letter, has pointed out the fact that, since the Russian, like English, is deficient in a feminine form for the word "holostiaki," here translated "bachelors," the plural might reasonably be taken to cover both sexes, as "men," in phrases like "the children of men," in English, is understood to include both sexes. He suggests that "unmated animals," both sexes being understood, would be a possible, even preferable, translation. If no other light on the question existed than is contained in the letter itself, it would not be necessary to accept the narrow translation of "bachelors" used in the British text.

Fortunately, however, we do not have to depend solely upon the letter itself. The report of Yanovsky was made to the Russian authorities at St. Petersburg. The letter, giving its gist, is one addressed the following spring, that is, in 1821, to the administrator of the Russian-American Company on the seal islands, for his information and instruction. In the article of Bishop Veniaminof, page 369, we find this statement as translated by Professor Zon:

> Only in 1822 Muraview, the head administrator, ordered to leave every year young seals for breeding.

The head administrator did not order "bachelors" left, but "young seals," which

includes both sexes. We have a right to assume that this order was an intelligent interpretation of Yanovsky's recommendation. He had reported that the young seals were too closely killed; the order was that a reserve of such animals should be set aside for breeding purposes.

It may be noted, therefore, that the testimony of the Russian agent Yanovsky is that in the period at and prior to 1820 the Russians were killing young female seals.

The statements of Bishop Veniaminof are much more detailed and definite. In the Zon translation from page 353 of the Zapiski, we read:

> Under the name Kotiki, or gray pups, are classed the four-months-old males and females, which were born in the spring and which form the largest and almost the entire quantity of seals used in the trade.

This means that the Russian sealing took chiefly the gray pups at the age of four months, male and female alike. Amplifying this idea further, we may continue to quote from page 360:

> Some years in September the young pups form large pods and congregate in special places and lie carelessly, so that they all can be driven off without leaving a single one behind. Such pods are very advantageous for the trade but are the most ruinous for the increase of the herd.

The reason for this is made plain on page 364. After describing at considerable length the Russian method of driving and sorting the seals, which was from the breeding grounds and included all classes of animals, he concludes with these words:

> As soon as they are rested the killing is begun with clubs. Small pups which were born the same summer are killed without discrimination, both males and females.

These are very positive statements and there can be no doubt about the translation. They confirm the statement of Yanovsky that the Russians killed the young seals too closely, leaving only the "old breeding animals" for propagation. As these older animals died off in the course of time through natural termination of life, the herd necessarily declined.

The account of Veniaminof adds other details of importance, among them that the general oversight and control exercised by the Russians was inadequate. He says, page 368:

> From the very discovery of the Pribilof Islands (1786) until 1805 . . . the industry on both islands was carried on without any plan, because at that time there were many companies and therefore many masters and each of them attempted to kill as many seals as possible.

As a result of this it was necessary to cease killing for a time, but the irresponsible methods were not reformed and so Veniaminof continues:

> From the time of those close seasons, that is on the island of St. George from the year 1808 and on the island of St. Paul from 1810 to 1822, killing was carried on on both islands without any economy and even with extreme negligence, so that even sikatchi (adult bulls) were killed for their skins and mother seals perished by the hundreds in the drives and in their journeys from the breeding grounds to the slaughtering places.

This is from page 369. Then came the order of Muraviev, already cited, following the report of Yanovsky—to save young seals for breeding. Even this order was disregarded, as we learn from page 371, where Veniaminof tells us,

> It was ordered that more care should be exercised in separating adult and young females from the seals which were being killed, and to try as far as possible to reserve some of those which would regularly be killed.

These are the Russian records in so far as they are available to us. They show that Russian sealing was not confined to the bachelors, as is the land sealing of to-day and that it included females as well as males.

This was all prior to 1834. The efforts toward reform of these early methods failed, one after another, because they were directed toward limitation or suspension of all killing for brief periods and not toward the elimination of indiscriminate killing. With the crisis of 1834 came a complete change in Russian methods. Prior to that time the driving had

been from the breeding grounds, old and young, males and females, being subjected to the strain of the process, the lack of proper oversight and care, rendering it destructive in the extreme. Adult females, young females and female pups were regularly killed. The driving was now limited to the hauling grounds, frequented only by the bachelors, or young immature males, and these animals alone were killed. The females, adult and young, were everywhere protected from driving and from killing. This was the condition of the industry at the time it passed into American control in 1868. The depleted herd of 1834 had been restored to a maximum condition of growth and for twenty years thereafter it yielded a fixed product of one hundred thousand skins annually.

That it has not continued to yield this product was due simply to the fact that there developed, after the year 1880, a new industry carried on at sea, which by 1894 had exceeded in its annual catch the maximum product taken on land. Indiscriminate in its nature, that is, including the females as well as the males and causing the destruction of the unborn and dependent young, male and female alike, the effect of pelagic sealing was necessarily to throw the herd again into decline and in the end to bring it to a state of collapse similar to that experienced in 1834. Neither land sealing as such nor pelagic sealing as such was the cause of this. It was due solely to the killing of females. Just prior to 1911 the killing of females occurred in the sea in connection with pelagic sealing. Prior to 1834 it occurred on land in connection with the undeveloped and unperfected Russian land methods.

As the cessation of the killing of females by the Russians after 1834 stayed the herd's decline and provided amply for its recuperation, so the suspension of pelagic sealing, effected by the treaty of July 7, 1911, is an adequate remedy for the recent decline in the herd and a guarantee for its restoration and future protection.

The suspension of land sealing, incorporated in the law giving effect to this treaty of 1911, was a wholly unnecessary measure—wasteful in the extreme, and certain in the end to be harmful to the breeding life of the herd.

GEORGE ARCHIBALD CLARK

SCIENTIFIC NOTES AND NEWS

DR. AUGUST WEISMANN, professor of zoology at Freiburg since 1867, died on November 6, at the age of eighty years.

THE twenty-third annual meeting of the American Psychological Association will be held in affiliation with the American Association for the Advancement of Science, the American Society of Naturalists and the Southern Society for Philosophy and Psychology at the University of Pennsylvania, Philadelphia, Pa., on December 29, 30 and 31. Professor R. S. Woodworth, of Columbia University, is the president and Professor R. M. Ogden, of the University of Kansas, is the secretary.

THE American Phytopathological Society has selected the Hotel Walton as headquarters during its meeting in Philadelphia, December 29 to January 1. Members should make their reservations at once. Material for the pathological exhibition may be forwarded in care of Dr. Allen J. Smith, Room 214, Medical Building, University of Pennsylvania.

MARTIN G. BRUMBAUGH, Ph.D. (Pennsylvania), governor-elect of the state of Pennsylvania, was professor of pedagogy in the University of Pennsylvania from 1895 to 1900 and from 1902 to 1906, since when he has been superintendent of schools for Philadelphia.

AT the meeting of the Association of American Universities at Princeton University, on November 7, President George E. Vincent, of the University of Minnesota, was elected president; President Arthur T. Hadley, of Yale, vice-president, and Provost Edgar Fahs Smith, of the University of Pennsylvania, secretary. President John Grier Hibben, of Princeton, and President Thomas H. McBride, of the University of Iowa, were elected to the executive committee.

AT the meeting of the Association of State University Presidents in Washington last week, President Benjamin Ide Wheeler, of the

University of California, was elected president and Dr. P. P. Claxton, U. S. Commissioner of Education, and President Harry B. Hutchins, of the University of Michigan, vice-presidents.

On the evening of October 19 a testimonial dinner was tendered to Dr. McCormick by the faculty and trustees of the University of Pittsburgh, on the completion of his tenth year as chancellor of that institution.

At a largely attended dinner at the Sherman Hotel, Chicago, on November 9, the Chicago Pathological Society presented Dr. George Howitt Weaver with an appropriate testimonial of its appreciation of his efficient services as secretary of the society for twenty consecutive years. Short addresses were made by Dr. J. B. Herrick, Dr. Wm. E. Quine, and Dr. L. Hektoen; Dr. Weaver responded.

Dr. Simon Flexner has been in Chicago to study the hoof and mouth disease and will continue the investigation by cultures in the Rockefeller Institute for Medical Research.

Dr. Allen J. McLaughlin, formerly of the Public Health Service, assumed the duties of his office as health commissioner of Massachusetts, at the beginning of November.

Dr. Henry P. Walcott has been reappointed chairman of the Metropolitan Water and Sewerage Board of Boston.

Dr. Arthur Harmount Graves has resigned his position as assistant professor of botany in the Sheffield Scientific School of Yale University, and is at present engaged in research at the laboratory of Professor V. H. Blackman, professor of plant physiology and pathology, Royal College of Science, South Kensington, London.

Mr. F. B. Sherwood, B.S. (1912, North Carolina A. and M. College), has been appointed assistant chemist to the North Carolina Agricultural Experiment Station.

Dr. Jacob Eriksson has resigned the position of chief of the phytopathological experiment station at Stockholm, Sweden.

On account of the war it has been agreed by the University of Chicago and the ministry of public instruction in Paris to postpone the lectures arranged to be given at the Sorbonne by Professor James Rowland Angell, head of the department of psychology and dean of the faculties of arts, literature and science.

Professor William E. Lingelbach delivered his inaugural address as president of the Geographical Society of Philadelphia on November 4. His topic was "Geography in Russian History." He was presented to the society by Mr. Henry G. Bryant, whom he succeeds as president.

On October 19, Dr. C. E. Ferree, of Bryn Mawr College, lectured before the Section of Astronomy, Physics and Chemistry of the New York Academy of Sciences on the efficiency of the eye under different systems of lighting.

The Syracuse Chapter of the Sigma Xi has held two meetings this autumn. On October 2 Professor E. D. Roe reported on the meetings of the American Mathematical Society at Brown University and the American Astronomical Society at Chicago, while Professor F. A. Harvey reported on Professor Rutherford's Washington lectures. On November 6 an address was given by Dr. E. C. Day on "Electric Currents Generated in the Eye by Light" and another by Professor L. H. Pennington on "Studies in Forest Fungi."

At the twenty-fifth anniversary of the Johns Hopkins Medical School, tablets set in the walls of the hospital were dedicated to the honored dead. The *Journal* of the American Medical Association states that one of these tablets is in memory of Dr. John Hewetson who was assistant resident physician at the hospital from 1890 to 1894. Another in the lobby of the main hospital building is inscribed with the name of the late Dr. D. C. Gilman, first president of the university, one with that of Dr. James W. Lazear, who gave his life to study yellow fever and one with that of Dr. Rupert Norton who died a short time ago while assistant superintendent of the institution.

The German newspapers print obituary notices of four university professors killed in

the war. They are Heinrich Hermelink, professor of church history at Kiel; Ernst Heidrich, professor of art and history at Strassburg; Ernst Stadler, professor of German philology at Strassburg, and Professor Frincke, the head of the Hanover-Muenden Forestry Academy. Dr. Julius Liebmann, assistant in the Babelsberg Observatory, has also been killed in the war.

The Swedish-English Antarctic expedition, headed by Dr. Otto Nordenskjöld, will start in September, 1915, and proceed to Graham Land. The expedition will include twelve members. The Swedish government has granted half the expenses, while the other half will be subscribed in England. This latter money has nearly all been guaranteed.

The *Journal* of the American Medical Association states that Surgeon Rudolph H. von Ezdorf, U. S. Public Health Service, has completed a malarial survey of Virginia, and reports that he has located breeding places of the malarial mosquito and has taken steps toward its eradication. The next step of the work is the determination of how many people are carrying malaria in their blood, while the third part of the work is educational. The State Board of Health proposes to do a considerable amount of educational and eradicatory work during the year.

Students in engineering schools are offered an opportunity to compete for $1,000 in prizes for essays on highway construction offered by the Barber Asphalt Paving Company.

Associate Professor J. Paul Goode, of the department of geography at the University of Chicago, has in preparation a series of maps for colleges and schools, one of them being a large wall map of South America. In the making of the last-named map, all available official source maps were used, and all the special maps of recent exploration. But in a great area between the Madeira and Tapajos rivers it was necessary to put the legend "unexplored," until the results of Colonel Roosevent's expedition down the "River of Doubt" were published. This map of South America with the location of the new river approved by Colonel Roosevelt, is one of a series of eighteen wall maps for use in colleges and schools upon which Professor Goode has been at work for some years and which is now nearing completion. There is a map of each continent, of the United States, of the world on Mercator's projection, and the world in hemispheres. Each of these is presented as a physical map and also as a political map.

After a period of several years' inactivity the Naturalist Field Club, of the University of Pennsylvania, is being reorganized by Dr. Colton, of the zoological department. Officers elected for the ensuing year are: *President,* R. Holroyd; *First Vice-president,* Miss Lensenig; *Second Vice-president,* S. Harberg; *Third Vice-president,* A. Kolb; *Fourth Vice-president,* Miss Richardson; *Secretary,* Miss Jerdine; *Treasurer,* C. Keeley. The club was organized with the special object of studying natural history in the field. This was done by taking field trips from time to time to different sections of the surrounding country. Observations of birds, flowers, insects, trees and geological formations were made. It is planned to follow out the same plans in the future, the only difference of the reorganized club being in its officers. Formerly members of the faculty held all positions, but in the future the affairs of the club will be in the hands of students. A room in the zoological laboratory will be reserved for the club, and a dark room for the purpose of developing photographs has been arranged.

The quarterly return of the Registrar-General dealing with the births and deaths in the second quarter of the year, and with the marriages during the three months ending March last, is abstracted in the *British Medical Journal.* The annual marriage-rate during that period was equal to 11.1 per 1,000 of the population, and was 0.1 per 1,000 less than the mean rate in the corresponding quarters of the ten preceding years. The 226,013 births registered in England and Wales last quarter were equal to an annual rate of 24.3 per 1,000 of the population, estimated at 37,302,983 persons in

the middle of the year. The birth-rate last quarter was 2.3 per 1,000 below the average for the corresponding period of the ten preceding years, and 0.4 per 1,000 below the rate in the second quarter of 1913. The birth-rates in the several counties ranged from 16.7 in Rutlandshire and 17.1 in Cardiganshire, to 29.8 in Glamorganshire and 32.3 in Durham. In ninety-seven of the largest towns the birth-rate averaged 25.5 per 1,000, and ranged from 13.1 in Hastings to 34.4 in Middlesbrough; in London the rate was 25.2 per 1,000. The excess of births over deaths during the quarter was 101,879, against 105,808, 102,293 and 105,-620 in the second quarters of the three preceding years. From a return issued by the Board of Trade it appears that the passenger movement between the United Kingdom and places outside Europe resulted in a net balance outward of 7,030 passengers of British nationality, and a balance inwards of 13,566 aliens. Between Europe and the United Kingdom there was a net balance inward of 19,308 British and of 15,887 aliens. Thus the total passenger movements resulted in a net balance inward of 41,731 persons. The deaths registered in England and Wales last quarter numbered 124,134, and were in the proportion of 13.3 annually per 1,000 persons living; the rate in the second quarters of the ten preceding years averaged 13.9 per 1,000. The lowest county death-rates last quarter were 8.8 in Middlesex and 10.2 in Rutlandshire; the highest rates were 16.1 in Lancashire and 16.7 in Merionethshire. In ninety-seven of the largest towns the death-rate averaged 13.8 per 1,000; in London the rate was 13.1. The 124,-134 deaths from all causes included 3 from smallpox, 307 from enteric fever, 2,677 from measles, 645 from scarlet fever, 2,658 from whooping-cough, 1,122 from diphtheria and 1,428 from diarrhea and enteritis among children under 2 years of age. The mortality from whooping-cough and diphtheria was approximately equal to the average; that from scarlet fever was slightly below the average; and that from enteric fever and measles was about two thirds of the average. The rate of infant mortality, measured by the proportion of deaths among children under 1 year of age to registered births, was equal to 88 per 1,000, or 10 per 1,000 less than the average proportion in the ten preceding second quarters. Among the several counties the rates of infant mortality last quarter ranged from 45 in Buckinghamshire and in Rutlandshire to 110 in Merionethshire and 111 in Lancashire. In ninety-seven of the largest towns the rate averaged 93 per 1,000; in London it was 79, while among the other towns it ranged from 36 in Bath to 143 in Middlesbrough. The deaths among persons aged 1 to 65 years were equal to an annual rate of 7.6 per 1,000, and those among persons aged 65 years and upwards to a rate of 79.8 per 1,000 of the population estimated to be living at those ages.

A SERIES of special lectures on chemical engineering will be delivered in the Mellon Institute of Industrial Research, University of Pittsburgh, as follows:

November 9—"Our New Knowledge of Coal," by Dr. H. C. Porter, chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

November 16—"Recent Researches on the Combustion of Coal," by Henry Kreisinger, engineer in charge of fuel tests, U. S. Bureau of Mines, Pittsburgh, Pa.

November 23—"Some Applications of Pulverized Coal," by Richard K. Meade, consulting chemist, Baltimore, Md.

November 30—"Producer Gas," by Dr. J. K. Clement, physicist, U. S. Bureau of Mines, Pittsburgh, Pa.

December 7—"The Softening of Water for Industrial Purposes," by James O. Handy, director of research, Pittsburgh Testing Laboratories, Pittsburgh, Pa.

December 14—"The Classification of Clays," by Professor Edward Orton, head of the department of ceramics and dean of the College of Engineering, Ohio State University.

January 4—"The Effect of Heat on Clays," by Albert V. Bleininger, director, Technological Laboratory of the U. S. Bureau of Standards, Pittsburgh, Pa.

January 11—"The Manufacture of Structural Clay Products," by Albert V. Bleininger.

January 18—"The Manufacture of Refractories," by Kenneth Seaver, chief chemist of the Harbison-Walker Refractories Co., Pittsburgh, Pa.

January 25—"The Manufacture of Porcelain," by Ross C. Purdy, chief chemist of the Norton Company, Worcester, Mass.

January 25—"Glazes and Enamels," by Albert V. Bleininger.

February 1—"Special Phases of the Glass Industry," a symposium, by Chas. H. Kerr, Pittsburgh Plate Glass Co., Pittsburgh, Pa.; Dr. S. R. Scholes, assistant director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.; Professor Alexander Silverman, professor of chemistry, University of Pittsburgh.

February 8—"Special Methods of Pyrometry," by Dr. H. S. Stupakoff, director of the Stupakoff Laboratories, Pittsburgh, Pa.

February 15—"The Present Status of the Chemical Technology of Vanadium," by Dr. B. D. Saklat-Walla, chief chemist of the American Vanadium Co., Pittsburgh, Pa.

February 22—"The Manufacture of Steel Tubing," by F. N. Speller, National Tube Company.

March 1—"The Manufacture of Steel in the Electric Furnace," by Professor Fred Crabtree, professor of metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa.

March 8—"The Corrosion of Iron and Steel," by Dr. D. M. Buck, American Sheet and Tin Plate Co., Pittsburgh, Pa.

March 15—"Catalysis," by Dr. M. A. Rosanoff, professor of research chemistry, Mellon Institute of Industrial Research, University of Pittsburgh.

March 22—"Recent Developments in the Electrochemistry of Organic Compounds," by Dr. Harold Hibbert, research fellow, Mellon Institute of Industrial Research, University of Pittsburgh.

March 29—"Industrial Applications of the Phase Rule," by Dr. M. A. Rosanoff.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Dr. George S. Lynde, of New York, Bowdoin College is left $10,000, Phillips Exeter Academy $20,000, as a memorial to Dr. Lynde's parents, and Yale University is made the residuary legatee. The value of the estate is not given.

The E. H. Skinner Company, of Boston, are now at work constructing a new $25,000 organ for Oberlin College, which will be located in Finney Memorial Chapel. The new organ is the gift of Frederick Norton Finney, of Pasadena, California, and of Charles M. Hall, of Niagara Falls.

The University of Strassburg, like the other German universities, has opened the semester at the usual time.

A member of the faculty of the University of Louvain has been engaged to give courses at the University of Chicago during the winter and spring quarters, his salary to be paid by Chicago. The name of the lecturer and his field of work will be announced later.

The master of Christ's College, Cambridge, states that the university is taking in Belgian students from all Belgian universities, and a committee is endeavoring to organize systematic teaching in French and Flemish, and also hospitality. There are already some fifty students and more than twenty professors in residence. Though the resources of the committee are limited, no student need be kept away by want of means. The master of Magdalen states that there are a number of Belgian professors at Oxford, including nine from Louvain, that a Belgian student's committee has been formed, and that it is intended to give facilities to professors and students for free admission to university institutions and lectures.

Dr. Sidney E. Mezes, president of the University of Texas and previously professor of philosophy at that institution, has accepted the presidency of the College of the City of New York, vacant since the resignation of Dr. John H. Finley to become state commissioner of education.

Dr. James Rowland Angell, professor of psychology and dean of the faculties of arts and literature at the University of Chicago, has been offered the presidency of the University of Washington.

Dr. F. M. Barnes, Jr. has resigned from the faculty of the medical school of the St. Louis University, to become associate in psychiatry in Washington University.

The following additions have been made to the staff of the chemistry department of the North Carolina College: C. F. Miller, B.S.

(Wesleyan, '09), Ph.D. (Cornell, '14); E. L. Frederick, A.B. ('11), Ph.D. (Johns Hopkins, '14); J. T. Dobbins, A.B. ('11), A.M. ('12), Ph.D. (North Carolina, '14).

New appointments at the Rice Institute are as follows: Claude William Heaps, B.Sc. (Northwestern), Ph.D. (Princeton), of Columbia, Mo.; formerly fellow of Princeton University; instructor in physics at the University of Missouri, to be instructor in physics; Arthur Romaine Hitch, B.A. (Washington), Ph.D. (Cornell), of Syracuse, N. Y.; formerly assistant instructor in chemistry at Cornell University, research chemist of the Solvay Process Company, Syracuse, N. Y., to be instructor in chemistry; Herbert Kay Humphrey, B.Sc., in electrical engineering (Illinois), M.Sc. (Union), of Schenectady, N. Y., consulting engineer of the General Electric Company, Schenectady, N. Y., to be instructor in electrical engineering; Joseph Horace Pound, B.Sc. in mechanical engineering (Missouri), of Pittsburgh, Pa.; engineer and instructor in the School of Apprentices of the Westinghouse Machine Company, to be instructor in mechanical engineering; Edwin Eustace Reinke, M.A. (Lehigh), Ph.D. (Princeton), of Princeton, N. J., formerly Proctor fellow of Princeton University, to be instructor in biology; Radoslav Andrea Tsanoff, B.A. (Oberlin), Ph.D. (Cornell), of Worcester, Mass., formerly Sage fellow of Cornell University; instructor in philosophy at Clark University, to be assistant professor of philosophy; William John Van Sicklen, M.A. (Stanford), of Palo Alto, Calif., instructor in chemistry at Stanford University, to be instructor in chemistry.

DISCUSSION AND CORRESPONDENCE

THE ASSOCIATION OF UNIVERSITY PROFESSORS

To the Editor of Science: In the current number of *The Atlantic Monthly* there appears, on one of the pages devoted to biographical sketches of the contributors, a statement concerning the committee on the organization of a national Association of University Professors, to which reference is made in Professor H. C. Warren's valuable article on "Academic Freedom" in the same issue. The statement seriously misrepresents the functions of the committee and the purposes of those interested in the organization of the new society; and it is published without the committee's authorization, and, as Professor Warren permits me to say, without that of the author of the article. The committee is in no sense a body for the investigation of grievances or for the examination of internal conditions in American universities. Its only duty is to prepare plans for the formation of a representative professional organization of university teachers. The committee has defined its own understanding of the purposes of the organization as follows:

> . . . to bring about more effective cooperation among the members of the profession in the discharge of their special responsibilities as custodians of the interests of higher education and research in America; to promote a more general and methodical discussion of problems relating to education in higher institutions of learning; to create means for the authoritative expression of the public opinion of the body of college and university teachers; to make collective action possible, and in general to maintain and advance the ideals and standards of the profession.

It may perhaps be well to take this occasion to report to those interested that the committee expects to call a meeting for the formal organization of the association during the last week of December. The day and place can not yet be announced. The committee, after much discussion, determined last spring that members of the profession should, at least at the outset, be asked to adhere to the association as individuals, and not as representatives of their local faculties. The committee is therefore about to send out invitations to a large number of university and college professors who are known to the committee, or to those who have been called upon for advice in the matter, as well qualified representatives of the several sciences. Doubtless, through the limitations of the knowledge of the committee and its advisers, many to whom invitations should be sent will be overlooked. It is not contemplated, however, that the eventual

membership of the association will be limited to those who will be asked to attend this meeting. The committee merely sought, by the means indicated, to bring together a body much larger and more representative than itself, which may constitute a nucleus for the association, and to whose judgment the committee may submit its recommendations.

The committee is not empowered to define authoritatively either the purposes or the scope of the association, or the conditions for membership in it. It is, however, to be expected that the association's future policy with regard to these matters will be determined at the meeting to be held next month.

Since the previous announcement of the *personnel* of the committee, the following members have been added to it:

G. B. Frankforter,
University of Minnesota,
H. B. Mumford,
University of Illinois,
C. E. Bessey,
University of Nebraska,
Samuel B. Harding,
University of Indiana,
Percy Bordwell,
University of Iowa,
T. S. P. Tatlock,
University of Michigan,
J. W. Garner,
University of Illinois,
C. D. Adams,
Dartmouth College.

The chairman of the committee, Professor John Dewey, of Columbia University, or the undersigned, will welcome suggestions from any member of the university teaching profession relating to the plan of organization and the future work of the proposed association.

ARTHUR O. LOVEJOY,
Secretary

BALTIMORE,
November 3, 1914

ATMOSPHERIC OPTICAL PHENOMENA

TO THE EDITOR OF SCIENCE: The letters from Messrs. H. W. Farwell and A. W. Freeman, published in SCIENCE, October 23, 1914, pp. 595–596, are two of the many recent indications of the fact that more attention is now being given than formerly to the observation of atmospheric-optical phenomena. The meteor seen by Mr. Freeman was not, as he supposes, a tertiary rainbow, but the circumzenithal arc of a solar halo. This particular arc is also known as the upper quasi-tangent arc of the halo of 46 degrees.

The complex halo observed by Mr. Freeman at Fredericksburg, Va., November 2, 1913, was visible, in various degrees of development, on November 1 and 2, at a great number of places throughout the eastern half of the United States, and constituted the most remarkable display of the kind heretofore recorded in this country. It should be noted that the small arc, convex to the sun, marked "rainbow" in Mr. Freeman's drawing, was the same phenomenon as that observed by Mr. Farwell, *i. e.*, the circumzenithal arc of a halo. The term "rainbow" is highly inappropriate for this or any other halo phenomenon.

Mr. Freeman's observation is noteworthy on account of including the rare phenomenon of the anthelion—a white mock-sun directly opposite the sun in azimuth, and at the same altitude above the horizon. The large outer circle, shown in the drawing, extending around the horizon, is the parhelic circle, a well-known though rather uncommon phenomenon. The inner, partial circle, drawn parallel to this, is decidedly unusual. It appears to be a secondary parhelic circle, produced by the upper vertical parhelion of the 22-degree halo serving as luminous source. This and other secondary halo phenomena produced by parhelia have been described by Bravais and Besson.

The August number of the *Monthly Weather Review*, which has just appeared, contains a translation of a recent memoir by Besson describing all known forms of halo. No such comprehensive account of these phenomena has heretofore been published in English. The same number of the *Review* contains an extensive report on the halos of November 1–2, 1913.

C. FITZHUGH TALMAN

U. S. WEATHER BUREAU

QUOTATIONS

FOOT-AND-MOUTH DISEASE

In view of the recent outbreak of foot-and-mouth disease in the Mississippi Valley, the most extensive as yet in the United States, a brief consideration of the principal features of the disease may be of interest. It is an acute, highly infectious disease, which occurs chiefly in cattle, sheep, goats and swine, though other animals such as the horse and dog, as well as certain wild animals are attacked also, and it may affect human beings. In animals it is characterized especially by the eruption of vesicles in the mouth and on the feet, in some species more in the mouth, in others more on the feet. It cattle the incubation period averages from three to five days, whereupon a moderate fever with loss of appetite and other general symptoms sets in. In two or three days small blisters appear on the lining of the mouth, and now the fever usually subsides. At the same time one or more feet may show tenderness and swelling of the skin, soon vesicles form here also, and the animal goes lame. In the mouth the blisters may reach half an inch or more in diameter, but usually they are smaller; the contents, at first clear, become turbid, and as the covering bursts, small painful erosions are produced which either heal quite promptly or turn into ulcers that heal more slowly. Usually the milk is altered and reduced in quantity; blisters and ulcers may form on the udder. There is marked loss of weight, as the animals do not eat because of the pain. In this, the ordinary form, in which the death-rate is very small except among the young, the symptoms fade away in from ten to twenty days or so, except when complicating local secondary infections delay recovery, but there are also severe forms with extensive infection of the respiratory tract and gastro-intestinal inflammation, which frequently end in sudden death. In such severe cases ulcers are found in the stomach and intestines. In sheep and swine, lesions of the feet predominate. The disease is transmissible to the fetus in utero.

The cause of the disease is present in the contents of the vesicles, the discharges from the ulcers, the saliva, the milk, the urine and feces, but as a rule not after the tenth day. It is stated that animals having had the disease may carry the virus for months.[1] Any susceptible species may infect any other susceptible species. Infection occurs not only through direct contact, but also indirectly, as the virus retains its virulence for some little time, at least outside the body. Contamination of fodder, of stalls, of feeding and drinking troughs, of milk and milk products and of the hands and clothes of drovers serves to spread the disease, which often travels over wide stretches of country with remarkable rapidity, as shown by the present outbreak. As from 25 to 50 per cent. of the cattle exposed to infection may become sick, there results great loss from fall in the production of milk, from reduction of vitality and fecundity, and from deaths as well as on account of the measures adopted to stamp out the epizootic.

The immunity produced by an attack seems to be feeble, as animals are said to suffer sometimes more than one attack within a short time. So far no practical method of protective inoculation has been developed.

Our knowledge of the cause of foot-and-mouth disease is limited to the fact that it concerns a filterable virus, as yet invisible and incultivable. It was in 1897 that Löffler and Frosch made their classical experiment, showing that the disease is caused by a living, proliferative virus that passes filters which do not permit bacteria to go through, an experiment that has served as a model for all the subsequent work on the many other forms of filterable virus recognized since then. Foot-and-mouth virus may remain active for months if kept cool and moist, but is destroyed rapidly by drying, by heat at 60° C. (140° F.) and above, by formaldehyd and by phenol (carbolic acid). The wide range of virulence of this virus among animal species has been indicated, and as stated, the disease may affect human beings, especially children, being transmitted by milk from diseased cows (experimentally verified) and by butter and cheese made from such milk as well as through

[1] Moore, "The Etiology of Infectious Diseases in Animals," 1906.

wounds and in other ways. While the course usually is favorable, an epidemic described by Siegel had a mortality of 8 per cent. The manifestations are fever, digestive disturbances and vesicular eruption on the lips, the oropharyngeal lining ("aphthous fever") and sometimes on the skin. Where there is danger of contamination of the milk with the foot-and-mouth virus, thorough pasteurization of all milk and milk products is doubly indicated.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Perception, Physics and Reality. By C. D. BROAD, M.A., Fellow of Trinity College, Cambridge. Cambridge University Press. 1914. Pp. xii + 388.

The essay of Mr. Broad is the outgrowth of a dissertation presented to Trinity College, Cambridge, at the examination for fellowships. As now published it is an enquiry into the information that physical science can supply about the real. Evidently the speculative tendencies of recent science have attracted the attention of philosophers, and to some extent their envy. As Mr. Broad says: "When a certain way of looking at the universe meets with the extraordinary success with which that of physics has met it becomes the duty of the philosopher to investigate it with care; for it is likely to offer a very much better cosmology than his own unaided efforts can do." This success is due to the fact, he thinks, that most scientists start from a position of naïf realism. The only successful rival, at the present time, to this realism is the phenomenalism which has resulted from the work of Mach and his followers. And this phenomenalism which holds that the objects of our perceptions are non-existent except when they are perceived is not according to Mr. Broad, an adequate foundation for a scientific system. He thus disapproves of the modern physicists who are regarding energy and electricity as entities rather than as attributes.

The essay begins with a discussion of the arguments which have been advanced against naïf realism, and after weighing the evidence he comes to the conclusion "that none of these arguments which are so confidently repeated by philosophers really give conclusive reasons for dropping even the crudest kind of realism." Since it is difficult to advance in science without a belief in some law of cause and effect, he next discusses the arguments which philosophers have advanced against causation. This is followed by chapters on the arguments for and against phenomenalism and the causal theory of perception. The essay closes with a comparison between Newtonian mechanics and the so-called new mechanics which is based on variability of mass with speed. Mr. Broad is quite conservative, for while he does not say that the principles of mechanics which have become classic may not require revision from time to time, yet "the more general laws will still be laws about positions and velocities of some extended quality or qualities, and, as such, will be capable of the same sort of defence that I have offered for the traditional mechanical physics." His opinion is not of great value to the physicist who is not asking for a defence of traditional mechanical physics but who is much worried about the nature of "some extended quality or qualities" which has position and velocity. He is anxious to know whether it is matter, electricity or energy.

The philosophical method of Mr. Broad is that of the neo-realists and he owes much, as he acknowledges, to the lectures and conversation of Mr. Bertrand Russell. His point of greatest departure from Mr. Russell's teaching is perhaps the substitution of the criterion of probability for certainty. This is to make philosophy approach more closely to science. As he says in his introduction: "I have constantly put my conclusions in terms of probability and not of certainty. This will perhaps seem peculiar in a work which claims to be philosophical. It seems to me that one of the most unfortunate of Kant's *obiter dicta* is that philosophy only deals with certainty, and not with probability. So far is this from being the case that to many philosophical questions about the nature of reality no

answer except one in terms of probability can be offered; whilst to some there seems no prospect of an answer even in these terms. Few things are more pathetic than the assumption which practically every philosopher makes that his answer to such questions is the unique possible answer; and few things are funnier than the sight of a philosopher with a theory about the real and the nature of perception founded on numberless implicit assumptions which, when made explicit, carry no conviction whatever, telling the scientist *de haut en bas* that his atoms and ether are mere economical hypotheses." This is a rather long quotation, but it gives very vividly Mr. Broad's philosophical standpoint. While it is a good and safe attitude, one can not help wondering what the value of a philosophical determination of reality may be. Reality which depends at best on its *probable* truth is a doubtful reality and must continue to be a question of dispute. Does it not become ultimately a question of temperament; one either is convinced of the reality of the external world, or he is not, and logic will have but little effect on his judgment?

Mr. Russell and his followers are able to give a specious appearance of certainty to their deductions by employing an esoteric system of mathematical symbols and analysis. He, himself, is both a mathematician and a philosopher. As the former, he must know that mathematical analysis will not give correct conclusions if the postulates contain an error. He must also know that even if the postulates be correct, the conclusion is without meaning if the idea represented by a given symbol should change to an appreciable extent during the transformations. For example, if V represents a *constant* velocity and if, during an experiment, the velocity should change by a measurable amount, then no conclusion could be drawn from our analysis unless V is changed to V', and in addition we know the exact relation between V and V'. The reason why mathematics can be applied to interpret physical and astronomical phenomena so satisfactorily is because the ideas represented by the symbols in those sciences are simple and can be measured with great accuracy. Now this is not the case, except to a much more limited degree, even with the other sciences, and it certainly does not obtain for the far more complex questions of philosophy.

While Mr. Broad employs the method of Mr. Russell more or less throughout his essay, yet he rarely goes so far as to use the very irritating symbolism of his teacher. He has in fact only two specific examples, and of these the one on page 318 applies to a complicated problem of motion; the other example, on page 165, is better suited as an illustration for criticism. Here p is the proposition, phenomenalism is true; and q is the proposition that the objects of our perceptions depend on the structure of our organs. Can we prove p from this? By a manipulation of p and q which is printed so as to resemble a bastard kind of mathematics, he arrives at the conclusion that we can not prove p from the argument. We know that Berkeley was so shocked when he arrived at the same conclusion that he created God so that there might be a reality which could always perceive our organs of perception and thus give them a kind of pseudo-reality when no one else was near enough to perceive them. But that is not the point. It is pretty certain that q stands for so complex an idea or proposition that each of Mr. Broad's n readers will have received an idea differing sufficiently from the others to make it advisable to represent the proposition in these varying aspects by the series $q_1, q_2, q_3, \ldots q_n$. And furthermore, during an extended argument, each one's idea will, I think, change sufficiently to require changes in his q. The result is that q becomes the highly complex series $q_1, q_2, \ldots q_n$; $q_1', q_2', \ldots q_n'$; $q_1'', q_2'', \ldots q_n''$, etc. Not even the mathematical laws of probability can cope with such a problem.

The fact is, no philosophical method has been devised which can settle the questions involved in realism and phenomenalism. But much can be gained by a discussion of the arguments for and against these ideas. And it is in this discussion that the interest and value of Mr. Broad's essay are displayed.

Scientists, especially, should read the book, if for no other reason than to convince themselves how metaphysical their scientific hypotheses are.

Louis Trenchard More
University of Cincinnati

Essentials of College Botany. By Charles E. Bessey, Professor in the University of Nebraska, and Ernest A. Bessey, Professor in the Michigan Agricultural College. American Science Series. The eighth edition revised and entirely rewritten. Henry Holt & Co. 1914. Pp. xiv + 409 with 206 illustrations.

The authorship of this essentially new book is unique in American botanical literature, and as a fitting foreword it is a pleasure to recall that the senior author has spent over two score of years in the constant and very fruitful pursuit of botany. The junior author, the son, was therefore reared in an invigorating atmosphere of phytology, since which he has been at the head of the department of botany in the Michigan Agricultural College, the very place where the father began, as an undergraduate, the serious study of the subject conjointly expounded in this text-book fresh from the press.

As a winning football team is sometimes built up around a star player, so here it is quickly noted that the book in hand has a dominant feature, namely evolution, and its title might well be phytophylogeny. In other words in the groundplan one sees fourteen phyla (branches) of the vegetable kingdom arranged in the order of the probable appearance of their members (species) in point of geologic time. The senior author has long specialized in taxonomy, publishing his results from time to time in pamphlet form, as, for example, "A Synopsis of Plant Phyla" (1907), and now the botanical world welcomes the appearance of the present work in which phylogeny is made the keynote of a text-book.

The phylum is the group unit employed for expanding the fundamental doctrine of evolution, namely, that the first species were low plants and from them have evolved all others, thus making all species genetically related, whether far or near, low or high. The lowest of the fourteen phyla is the myxophyceæ (slime algæ)—(the slime fungi find no place in the plant kingdom), and ends with anthophyta (flowering plants). Each phylum has its separate chapter, in which the dominant feature is considered through "laboratory studies" of types followed by a short bibliography. Thus, for example, "phylum V., phæophyceæ—the brown algæ" has for its characteristic idea the addition of the brown pigment, with which certain structural features are associated. This phylum is a lateral divergence from the main evolutionary stem. Again "phylum VIII., bryophyta—the mossworts," is derived from the Chlorophyceæ (simple algæ), shows (*a*) obvious alternation of generations, (*b*) beginnings of conductive tissue and (*c*) the members grow upon land. "Laboratory studies," as usual, are given under the classes, namely, liverworts and mosses.

The last chapter, and last phylum, deals with anthophyta (flowering plants) and includes more than a half of all known plant species. In the laboratory the pupil will here receive the instruction that usually is found in the early pages of the less modern text-books. This chapter closes with a tabulation of the "greater steps" in the development of the highest from the lowest plants.

While the method here followed is logical from the evolutionary viewpoint, as a matter of fact many pupils get into college seriously deficient in botanical perspective, and therefore a few preliminary lessons upon the more evident parts of the higher plants and something of their functions would be advantageous before "making the plunge" into the depths of protoplasm, the most complex of all substances when measured by its boundless activities and possibilities. Therefore it might not be a crime to begin the class with a portion of this last chapter, thus bringing the pupils even by way of review in closer touch with the worldwide out-of-door botany. Next to kinship is social relations, and one wishes that the pupils might be introduced to plant societies, that is, to the environmental factors, namely, ecology,

but that is, perhaps, too far afield for this work, and a companion to it upon field botany may follow.

Concerning the fourteen phyla it is evident that number of species is no criterion as, for example, the calamorphyta with its twenty-four existing species, in a single genus of insignificant plants, stands in the same grade of groups with anthophyta with its 132,000 present-day species. The authors state that "philosophically a phylum originates with the incoming of a new idea. Stated structurally, it has its beginning with the development of a dominant morphological peculiarity. Stated taxonomically its initial point is indicated by the appearance of a new character." So long as the "new character" dominates the phylum remains, but later "ideas" may be expressed, and when they become dominant new phyla arise successively, and thus the phylogenetic tree is built up. It is evident that there might be some difficulty in securing the weights of new ideas in the scale pan of phylogeny, determine the dominance of a "morphological peculiarity" and the appearance in time of a "new character"—all of phylum grade, and therefore so long as the personal equation plays its rôle the last shift in the phylogenetic scheme is not yet made.

The "Key to the Phyla of Plants" follows directly upon the fourteen phylum chapters, occupies fifty pages, brings the classification down through classes, orders to families and under these last 683 groups illustrative genera are named. This feature of the book is closed with reproductions of wall charts showing in one the relationship of the phyla and in the other those of the orders in the anthophyta. These charts will be of great help in genetics and perhaps the publishers may be induced to issue them in large size for classrooms. It is a pleasant thought that these charts, when reduced to page size, suggest at first glance the forms of certain species of algæ and fungi.

The early chapters remind one of the first edition, particularly those upon "Tissues" and "Tissue Systems." More space for greater elaboration seems advisable here, and the single chapter upon physiology needs expanding to three upon nutrition, growth and reproduction, respectively, with possibly one upon pathology—a subject that nowadays can not be adequately treated in four small pages.

Chapter V. "The Chemistry of the Plant" is an assemblage of the plant constituents with their formulæ and occurrence. These pages do not admit of use as either text or laboratory studies, and would make an appropriate appendix, possibly associated with a similar grouping of phytophysical facts and principles.

Twenty-nine pages of index "speak volumes" for the book.

It is a matter of regret that in a text-book where evolution is the fundamental thought the subject of species-making is not presented somewhat fully and even historically in outline. Under the topic "Variations" both "natural selection" and "Mendelism" are touched upon and "mutations" barely mentioned. It is judged that the authors are essentially Darwinians who strengthen their book by frankly stating their ignorance of the way "inherited variations" arise. They are equally wise with their "we do not know" in other places in the text.

As a general criticism, previously hinted, the book seems too small for its contents. The tendency to list instead of to elaborate is felt, due doubtless to a fixed limit of space set by the series of which it forms a unit. The authors have done their work admirably under the pressure, and it is regrettable that the publishers are sometimes at fault. Fanciful colored pictures that inflame the imagination are not asked for, but clear photo- and line-engravings that supplement the text are demanded. Many of the illustrations are too small and "inky"; for example, those under physiology, and give the pages a "pinched" appearance. Even the full-page phylum charts require a reading glass, in parts, for their use. The proof-reader fails at times as in uniformity of type for botanical names of plants (*e. g.*, p. 53).

Botanical teachers and taxonomists and paleobotanists as well, can not but feel deeply thankful for the appearance of this new text-book differing from others in its point of view

and setting down in a concise and clear form the results of many years of very successful study and teaching of the subject presented. It may well become a new starting point for editions that should take on the size and type of illustration that the dignity of a college botany deserves. Here is a hearty welcome to the new text-book in phytophylogeny—The Besseys' Botany Book of Branches.

BYRON D. HALSTED

RUTGERS COLLEGE,
October 28, 1914

Botanical Features of the Algerian Sahara. By WILLIAM AUSTIN CANNON. (Publication No. 178, Carnegie Institution of Washington. 1913. 81 pages, 36 plates.)

The journey of which this paper is an account was made in order "to examine the more obvious features of the physiological conditions prevalent in the region in question and, in connection with these observations, to make some detailed studies of the root-habits of the most striking species of the native flora."

After introductory chapters on the geography and climate of Algeria, the writer proceeds with an itinerary of his trip through the desert. This portion of the paper contains a great deal of topographical detail, together with much that is of directly botanical interest, although presented in a somewhat desultory way. The important botanical data are treated more systematically in the "General Summary and Conclusions" (pp. 66–81).

The author's intimate acquaintance with the vegetation of the southern Arizona deserts makes his comparison of conditions there and in the Algerian Sahara of special interest and value. Some of the striking points of difference as summarized in the concluding paragraphs are: (1) the greater sparseness of the Saharan vegetation, as compared with that of Arizona, there being "probably no large area in southern Arizona, where the soil conditions are favorable for plants, where the water conditions are too meager to support a perennial flora of some sort. The greater aridity of the northern portion of the Sahara is evident, therefore, from the great contrast in its flora." Cannon therefore suggests the term "semi-desert" for the Arizona region in contrast with a true "desert" like the Algerian Sahara. (2) The smaller size of the individual plants, at least of the perennial species, in the Sahara. (3) The smaller development of spines. "What may be the proportion of armed to unarmed plants in the northern Sahara I do not know, but to a person familiar with the plants of southern Arizona, where spinose forms are very numerous, the Algerian plants do not appear especially well protected."

Attention is also called to the fact that while in the Arizona desert there are numerous species, among the Cactaceæ and other families which have a "water balance," *i. e.*, which during and immediately after rains store water in their tissues, to be drawn upon in periods of drought; few examples of this adaptation were met with in the Algerian Sahara. Cannon correlates this scarcity of "water balance" plants with the fact that in Algeria there is but one rainy season. He notes that in the Tucson region, where such plants are numerous, there are two rainy seasons during the year, while in the desert region farther west, where but one well marked rainy season occurs, succulent plants are few or wanting.

The author's studies of the root habits of desert plants in Arizona led him to devote especial attention to this feature of the Saharan vegetation. The results of his investigations are summed up as follows: "A study of the relation of the root-type of the Algerian plants to the plant's distribution leads to the same general conclusion already obtained by similar but more extended study in the Arizona desert, namely, that the connection is often a very close one and often of definitive importance. Where the root-type is an obligate type the distribution of the species is much restricted, but where it undergoes modification with changed environment the distribution of the species is much less confined. It is of interest to note especially that as a rule it is the latter kind of root system that is developed by such plants as occur where the soil conditions are most arid, that

is, on the hamada or its equivalent, and not the former, from which it follows that the generalized type of root-system is really the xerophytic type *par excellence,* and not the type with the most deeply penetrating tap-root, as might be supposed." An interesting case of accommodation of root habit to character of the soil is mentioned: "The roots of *Haloxylon* on the hamada at Ghardaia develop both laterals and a main root, but in deeper soil, as at Biskra and Ghardaia also, the laterals are nearly suppressed and the tap-root is the striking feature."

The Algerian desert vegetation was found to have been greatly modified by grazing. In the vicinity of large towns, such as Ghardaia, the cemeteries, which are surrounded by walls, were practically the only places where the native vegetation could be found in a relatively undisturbed condition. The author comments on the fact that certain species, *Haloxylon articulatum,* for example, which are persistently grazed and of which the dissemination would appear to be very difficult, nevertheless remain extremely abundant. It is pointed out that this factor must have been operative even before domesticated animals were introduced into the region, since the native fauna includes several grazing animals. A striking indication of the modifying influence which the persistent action of this factor during many centuries must have had upon the vegetation is afforded by the present distribution of the betoum (*Pistacia atlantica*): "The betoum, which is the largest arboreal species in the Sahara, is confined to the region of the Dayas; that is, to the country immediately south of Laghouat. The tree is unarmed and is eagerly sought after by all herbivorous animals for its foliage and tender twigs. Owing to the presence of such animals, wild and domesticated, the young tree would have no chance to survive were it not that, growing in association with it, is the jujube (*Zizyphus lotus*), which is armed and is not eaten by any animals. The jujube affords safe protection for the seedling betoum, and in its capacity as nurse prevents predatory attacks by animals during the critical period. The survival (and probably the distribution as well) of the betoum is mainly conditioned on the presence of its protector."

At Ghardaia it was observed that many of the perennial species were resuming growth and beginning to flower in November, although no rain had fallen for twelve months. The following explanation is suggested: "Judging from analogy, therefore, it would appear that the stimulus to development on the part of the M'Zabite plants may be from the relatively better water relations made possible by a lower temperature without rain. In November at Ghardaia the evaporation rate is much below that of summer, that during the night being very small. Further, it was told me by good authority that the same species seen growing in autumn renew growth whenever rain chances to come, whatever might be the season. But it should be remembered that rain most commonly occurs in this region in winter, so that the plants may have a rhythm to which they usually conform, but from which they may depart, and that both stimuli (better water relations and lower temperature) are the annually recurring factors by which it may have been induced. Reference, of course, is made to perennials only, as no annuals were seen until the rains of spring made conditions favorable for their appearance."

Exposure appeared to be an important factor in plant distribution only near the northern edge of the desert.

"In parts of the Sahara visited where the most rain is reported, especially Laghouat and Biskra, plants were observed to exhibit exposure preference. Here the south or southerly facing slopes may have a floral composition different from the opposite exposure. In each instance the soil conditions, and apparently the moisture conditions also, were alike." Farther south, at Ghardaia, "provided there is sufficient depth of soil, apparently any species may be found on any exposure."

The numerous excellent illustrations showing the general appearance of various types of vegetation and the habit and root development of characteristic species are an attractive feature of this publication.

The scientific value of the facts and conclusions makes it regrettable that more attention was not paid to the manner of their presentation. The arrangement of the subject matter is not very satisfactory and there is a noticeable tendency to diffuseness and repetition. There is evidence on every page of hasty writing or of inadequate editing and proofreading. The want of precision in statement frequently leads to ambiguity.

These faults of style detract from the pleasure which the reader would otherwise derive from the interesting subject matter. In this respect the present paper is not peculiar, however, scientific writings being all too frequently deficient in literary form. The effectiveness of much good work in science is diminished through lack of care in its preparation for publication.

THOMAS H. KEARNEY
U. S. DEPARTMENT OF AGRICULTURE

British Antarctic "Terra Nova" Expedition, 1910. Zoology, Vol. 1, No. 1. Fishes by C. TATE REGAN, M.A. 4°. Pp. 54. Pl. I.–XIII. British Museum, Nat. Hist., June 27, 1914.

This is the first of the reports on the Natural History of the expedition conducted by the late Capt. Scott, R.N. The Antarctic fishes obtained comprise twenty-five species, of which four are new generic types and twelve species are new to science. Nearly all are from rather deep water. Most of the species belong to the Nototheniiformes. A new genus of the Bathydraconidæ resembles the northern Cottoid *Icelus* in its armature of bony spinose plates and the discovery of an Antarctic species of *Paraliparis* is interesting.

For the first time according to the author, the knowledge of the coast fishes of the Antarctic continent is sufficiently complete to make it worth while to attempt to delimit an antarctic zone and to divide it into districts. South of the tropical zone the distribution of coast fishes is thus classified by him. (1) South Temperate zone with seven districts: Chile, Argentina, Tristran d'Acunha, Cape of Good Hope, St. Paul Island, Australia and New Zealand. (2) Subantarctic zone, with the districts of Magellan and Antipodes, the latter including the island near and south of New Zealand. (3) Antarctic zone with the Glacial and Kerguelen districts. The Antarctic zone is characterized by the complete absence of South Temperate types and Bovichthydæ, and the great development of the other Nototheniiformes. The facts point to the conclusion that Antarctica may have been long isolated and that its coasts may have been washed by a cold sea probably throughout the entire Tertiary period. The author rejects the idea that it may have been connected with South America during recent geological time, as supposed by Dollo in the "Belgica" report. There has also been issued Vol. 11, Pt. 1, containing a twelve-page list of stations where collections were made, with full data, and four maps upon which the positions are indicated.

WM. H. DALL

SPECIAL ARTICLES

THE FAILURE OF EQUALIZING OPPORTUNITY TO REDUCE INDIVIDUAL DIFFERENCES

SEVENTY-TWO students in an undergraduate course in psychology did the experiment described in the note below.[1] Although this was primarily a test for fatigue there was, as is usually the case, an improvement with the

[1] Do experiment 36 at home and record the results. Follow the directions absolutely.

EXPERIMENT 36

Arrange to be undisturbed through a morning or an afternoon or evening. Provide yourself with a watch that records seconds. Multiply mentally, using the examples printed on this page, writing absolutely nothing until you have the entire answer to an example. Then write it and proceed at once to the next. Record the time at which you begin, and record the time at which you have finished each row. Do not stop at all except to record these times until you have finished all the examples or worked at least two hours. Do absolutely the best work you can throughout.

	653	537	927	847	286	728
A.	926	453	384	265	757	487

Nine similar rows were provided.

TABLE I

The Relation of Initial Ability in Mental Multiplication to Improvement: 76 College Students

	Average Score for First Row of Six Examples		Average Score for Final Row of Six Examples Done after Approximately 75 Minutes of Practise		Average Amount of Time Spent in Practise from Mid-point of First Row to Mid-point of Final Row	Gains	
	Amount per Minute	Percentage of Figures of Answers Correct	Amount per Minute	Percentage of Figures of Answers Correct		In Amt. per Minute	In Percentage Correct
Group I. 18 highest scoring....	.61	.86	.68	.87	72	7	1
Group II. 18 next highest......	.36	.80	.39	.80	81	3	0
Group III. 18 next lowest.....	.24	.80	.32	.83	74	8	3
Group IV. 10 lowest scoring....	.143	.76	.175	.78	71	3.2	2

exercise of the function. We may then compare the improvement made in the course of approximately 75 minutes of practise (I count from the mid-point of the first row's time to the mid-point of the time of the row such as makes this time from mid-point to mid-point as near to 75 minutes as possible), by those of initially high and those of initially low scores.

Doing this, we find the facts of Table I., (I.) for 18 individuals whose average score for the first row was at the rate of .61 examples per minute, (II.) for 18 individuals whose average score for the first row was at a rate of .36 examples per minute, (III.) for 18 whose average score for the first row was at the rate of .24 examples per minute, and (IV.) for 18 whose average initial rate was at the rate of .14 examples per minute. As the table shows, the initially high-scoring individuals made an equal gain in speed and somewhat less gain in accuracy, the net results being that they made about as much improvement as the others.

The same result appears in the case of addition where data from some 670 individuals give the facts of Table II.

These experiments add one more corroboration of the general result, so far uniformly attained, that equalizing opportunity does not reduce individual differences. Such experiments furnish a very strong argument against referring individual differences of unknown causation to differences in training, and in favor of referring them to original inherited characteristics in cases where they follow family relationships. We are unable experimentally to equalize training in such gross complexes as scientific achievement, literary fame, or reputation as a monarch. But we can easily do so with various minor capacities

TABLE II

Improvement Made in 1,800 Seconds of Practise at Adding Columns, Each of Ten Digits

Early refers to the ability estimated for the mid-point of the first day. *Late* refers to the ability shown after 1,800 seconds of practise, counting from the mid-point of the first day.

Time Required on Day 1	Number of Individuals in the Group	Number of Additions per 100 Seconds (Counting the Time of Writing the Answers Equal to One Addition's Time)			Approximate Number of Errors per 1,000 Additions, *i. e.*, Wrong Answers per 100 Ten-digit Additions		
		Early	Late	Change	Early	Late	Change
Under 400 seconds.	65	150	162	12	7.0	3.8	3.2
400 to 499	108	108	120	12	9.1	6.5	2.6
500 to 599	86	88	99	11	10.3	6.7	3.6
600 to 699	115	75	87	12	12.0	8.3	3.7
700 to 799	109	64	75	11	12.7	9.0	3.7
800 to 899	103	55	66	11	12.6	9.3	3.3
950 to 1,199	65	46	58	12	14.4	10.5	3.9
1,200 to 1,599 seconds.	20	37	46	9	17.5	14.4	3.1

such as the ones described here, and can do so without great difficulty with various school abilities.

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PHOSPHATE DEPOSITS IN THE MISSISSIPPIAN ROCKS OF NORTHERN UTAH

Since 1908 extensive work has been done both by private individuals and the U. S. Geological Survey to determine the amount and character of the rock phosphate in the Rocky Mountain region. The principal work of the investigation of the deposits, however, has been confined to the well-known horizon in the rocks of upper Pennsylvania of Permian age. It is now known that phosphate exists in the Mississippian rocks in a zone more than 2,000 feet stratigraphically below the phosphate horizon that has heretofore been given so much study.

The zone containing the phosphate is more than 100 feet thick and consists of layers of phosphate and black and brown shale with interstratified layers of sandy limestone. In extent it is known to outcrop in a north-south direction for more than forty miles, and sections studied show it to have an area of more than one hundred square miles. It has been reported as far south as Ogden Canyon[1] but no detailed section has been measured in that locality.

On the east side of Cache Valley the phosphate rocks have been prospected for coal and this exposure has given the best opportunity for detailed study. The face of the mountains which form the eastern boundary of the valley is a weathered fault scarp which terminates the western limb of a syncline. The ledges on the face of the mountain are exceptionally well exposed, the rock being principally bluish gray limestones with thin beds of shale and quartzite. Here the geologic section is well exposed and shows Silurian rocks at the base and Pennsylvanian at the top of the succession. Only the lower members of the Pennsylvanian or Permian are present in this locality.

[1] Blackwelder, U. S. Geol. Survey Bull., 430.

Observations on the face of the mountains, which extend more than 4,000 feet above the valley, show that the rocks strike N. 10° to 14° E., and dip eastward from 20° to 30°. The beds flatten to the eastward and about six miles east of the face they rise again, the strata on the eastern limb of the syncline dipping as much as 10° to the west. Erosion has clearly exposed the higher beds on the eastern limb of the syncline.[2] The phosphate rock is exposed on both the east and west limbs of the syncline which lies near the top of the range.

The Logan River has cut through the range from east to west, and has made a good exposure of all the strata included in the upper part of the synclinal fold. The phosphate zone, therefore, lies in two separate areas, one to the north and one to the south of the river. The Mississippian rocks are well up on the western side of the mountains forming the eastern boundary of Cache Valley and even in the lowest part of the fold in the canyon they are more than 1,000 feet above the river.

The zone containing the phosphate is exposed in a cliff of very compact bluish gray limestone which is usually more than a hundred feet thick and contains an abundance of cup corals. At the base of this cliff there is a lean phosphatic zone from five to seven feet thick of shale containing a few bands of chert. The shale also contains several thin layers of oolitic rock phosphate ranging from one half to one inch in thickness. One sample taken from all of these layers yielded only 7.21 per cent. tricalcium phosphate. This zone is probably of no economic value. It has been prospected in a number of places for coal.

The thicker and richer phosphate zone lies just above the thick ledge of limestone. The phosphate rocks are less resistant to erosion than the underlying and overlying limestone ledges and the latter stand out more prominently than the included softer beds. The rocks in the phosphate zone which are generally dark colored contain thin bands of nonphosphatic limestone with shale and some

[2] See Geological Map—parts of western Wyoming, southeastern Idaho and northeastern Utah—Hayden survey, 1877.

chert. Measurements of some of the beds were taken in Providence Canyon and are shown in the table below.

At the top of the phosphate zone the rocks are not sufficiently well exposed to afford detailed study. A tunnel driven near the upper limestone ledge shows a few inches of good rock phosphate interstratified with dark-colored limestone and shale.

Thirty feet below this ledge twenty inches of oolitic phosphate rock was measured and a sample (No. 1) yielded 55 per cent. $Ca_3(PO_4)_2$. In the next thirty feet below there are thin bands of oolitic phosphate but none of them are believed to be thick enough to be of economic value. The details of the lower part of the bed in Providence Canyon follow:

No.	Kind of Work	Per Cent $Ca_3(PO_4)_2$
	3 feet dark gray limestone	
2	18 inches phosphatic shale	30.10
3	12 inches shaly phosphate rock	16.71
4	48 inches dark shaly phosphate rock	65.43
	24 inches gray limestone	
5	48 inches shale, some layers phosphatic.	14
6	11 inches black shale	8.41
7	30 inches shale, oolitic phosphate, in bands	21.30
	24 inches sandy limestone	
9	38 inches phosphate rock, shaly	33.01
	18 inches chert	
	12 inches black shale	
10	30 inches phosphate rock	35.83
11	12 inches phosphate rock	46.34
	2 inches black chert	
12	48 inches black shale	3.91
	6 inches black chert	
13	21 inches black oolitic phosphate rock	65.76
	1 inch black chert	
14	12 inches black shaly phosphate rock	21.40
15	18 inches brown oolitic phosphate rock.	68.59
	bedding planes	28.31
	6 inches shale	
16	6 inches shale showing phosphate in	
	2 inches chert	
17	4 inches shaly phosphate rock	27.12
	20 inches sandy limestone	
18	18 inches brown oolitic phosphate rock.	66.9
	12 inches black shale	
	16 inches black shale with bands of chert.	
	5 inches brown oolitic phosphate rock.	52.22
	7 inches shale	
	2 inches oolitic phosphate rock with much hematite	
	Limestone ledge	

The samples for analysis were taken only two or three feet under the surface and it seems quite probable that they have been considerably leached for the rock is less firm and crumbles more easily than that from the upper Pennsylvanian or Permian horizon. No sampling has been done below the level to which roots penetrate. It is thought the amount of phosphate may decrease to some extent with depth, owing to the leaching of the less soluble constituents and the concentration of the phosphoric acid in the leached zone.

One very noticeable feature in the phosphate zone in this locality, which is an aid in tracing the phosphate, is that usually the growth of vegetation is denser along the line of outcrop than elsewhere. On hillsides which face the south and, therefore, have but little moisture or vegetation, growths of wild cherry, maple, and aspen extend along the outcrop. As a few small seeps and springs issue from the phosphate shales the denser vegetation there should perhaps be partly accounted for by the moisture.

At a place four miles north of the locality in Providence Canyon where the samples mentioned were obtained, two other samples were taken from separate layers of oolitic phosphate rock near the lower part of the deposit. The sample from one bed 18 inches thick yielded 55.21 per cent. tricalcium phosphate.[3] The other sample from a bed 42 inches thick yielded 61.32 per cent. of the material. The section does not seem to agree in detail with the measurements made in Providence Canyon. It is thought by the writer that the Mississippian rocks are sufficiently rich in tricalcium phosphate to warrant investigation as to their economic value.

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[3] The analyses were mostly made by Mr. C. T. Hirst in the Experiment Station chemical laboratory.

SCIENCE

FRIDAY, NOVEMBER 27, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS[1]

Two great things have occupied the center of attraction and thought in the affairs of this association and the institutions embraced in its membership during the past year. These are the Smith-Lever Extension Act and the changes in the relations of the agricultural colleges with the United States Department of Agriculture. The discussion of administrative questions involved in the new developments along both of these lines will consume a large share of the time of this convention. It is my purpose at the present hour to consider briefly some of the broader relations of these matters to the future development of the land-grant colleges and the Department of Agriculture.

The Extension Act has rounded out the Federal legislation providing for the endowment along agricultural lines of the institutions whose establishment was made possible by the land-grant act of 1862, not so much by liberal grants of money for extension work as by recognition of such work as a legitimate and necessary function of these colleges which ought to be performed throughout the nation. The chief importance of the new policy of the Department of Agriculture in its relations with these colleges is the recognition that this national institution, founded also in 1862 primarily for research and instruction in agriculture, is really a part of our national system of agricultural education, represented in the states by the land-grant colleges, and that therefore it should work not alongside of them but in close interlocking alliance with them.

The enlargement of the functions of both the colleges and the department due to the

[1] Read at the convention at Washington, D. C., November 11, 1914.

broad and rapid development of extension work is relatively so recent and as yet so incomplete that there has been little realization of its ultimate far-reaching effects. Undoubtedly it is too early for us to see very clearly what these will actually be and uninspired prophecy is always "a shot in the dark." On the other hand when we are laying the lines for a great and permanent enterprise it will not do for us to consider merely past experience and the pressing needs of the present. Whither are we going and what will be the goal of our efforts are reasonable questions and incomplete answers are better than none.

So far extension work in this country has been very largely an incidental function of the agricultural colleges and the department. I do not mean by this that it has been carried on in a small way. Large amounts of information collected by these institutions have been broadly disseminated through the printed page and by itinerant lectures. In recent years demonstration work and the activities of the county agricultural agents have assumed considerable prominence, but have been looked upon as in an experimental stage. In the main the colleges and the department have done extension work with funds under their immediate control and with agents sent out from the central headquarters. Now we have an Act of Congress permanently providing for "cooperative agricultural extension work," to be supported not only with federal and state funds, but also with contributions from counties, local authorities and individuals. The plan of organization already generally adopted involves the appointment of county agricultural agents as one of its leading features. Carried to its logical conclusion this means that the colleges and department will before long have a definite existence as educating agencies in practically every county of the United States. Through organization of the farm men and women into small groups they may ultimately have classes in agriculture and home economics in every school district. This is an educational organization radically different from that followed in the public school system of the United States where local initiative and control have largely obtained, state supervision has been very largely of a general character, and federal supervision has been entirely lacking. The agricultural college is to be changed from an institution having a strictly local habitat with comparatively limited powers for the diffusion of knowledge to a widely diffused institution dealing educationally with multitudes of people at their own homes. And it is to carry with it wherever it goes the national Department of Agriculture not only as a provider of funds but as an active coadjutor in its educational operations. And this education is to be not merely the giving out of information to be absorbed by the students but rather the training involved in active participation in the demonstration and discussion of practical affairs, which will constitute a large share of the extension instruction. Moreover this instruction will deal with matters which are of vital and immediate importance to the students since they will affect their incomes, daily practises, and community interests.

The character of the atmosphere and work of every educational institution is powerfully affected by the character and aims of its students. There is therefore no doubt that the reaction of the great masses of extension students on the agricultural colleges and the department will be a very important factor in their future development. This will manifest itself in various ways. The real problems of the farming people, for example, will be brought out much more definitely and clearly than heretofore and these will be pressed home upon the research workers in the stations and the department. The young people brought up in communities where the extension service has been well organized and effective will be much better prepared to enter the agricultural schools and colleges, but they will also not be satisfied with much of the instruction as now given in our agricutural colleges. The attitude of the farming people toward the colleges and the department will be broader and more sympathetic but it will also be more intelligently critical.

The results of the investigations of the de-

partment and the experiment stations, as well as the teachings of the agricultural colleges, will hereafter be put to a much more thorough practical test. When the county agent system is well established in any region it will naturally be expected that after a reasonable lapse of time the agriculture of that region will show definite improvement. Not only should there be better crops and animals but they should be so handled and marketed that the farmers will receive more satisfactory returns for their labor. Moreover the affairs of the farm homes and of the rural community should be more efficiently managed. It will no longer answer to state the agricultural progress of this region in general terms, however glittering. There must be definite facts and figures to prove every statement. And these should emanate not from the institutions and their agents who have been working there, but from the people for whose benefit the work has been done. It may be that the county agent will be directly responsible for the condition of affairs in his own county but everybody will know that he has had the backing of the agricultural college and the Department of Agriculture. These institutions will be held chiefly responsible for the success of their agents. No other educational system has had such severe tests of its practical value. Here are standards of judgment from which there can be no appeal. If this system was to be applied only here and there, failure might be attributed to some peculiar local conditions. But this is to be a national system whose failure, if there is failure, will be due to imperfect or false teachings and wrong methods of administration.

This new system, then, is not merely an important addition to the business of the agricultural colleges and Department of Agriculture for which they must make proper arrangements by appointing competent agents and securing the economical expenditure of public funds. It is of course to be expected that these institutions will put aside all political or other improper motives in the organization and work of the extension force. To gather about them and to send into the field a body of the most experienced and best trained men and women in thorough sympathy with the men, women and children on our farms, that existing conditions will permit, will indeed be a great achievement. To operate this force harmoniously and successfully under a cooperative system which involves the close alliance of national, state, county and local organizations, will be a most wonderful thing. But we may have the most competent extension force we can get throughout the nation and the most cordial relations among the cooperating agencies and yet our extension system may prove a comparative failure. And it will be this unless the colleges and the department look upon the extension work as a vital part of their organism, even as the feet and hands are parts of our human bodies. The blood that flows in this body must be rich and pure, the nervous force that propels it must be strong and active, the will that controls it and the spirit which emanates from it must be infused with the highest ideals of public service. Not only the administrative officers of the colleges and the department must work for the best development of the extension system as an organic part of their institutions, but the investigators and the teachers must feel and act toward the extension workers in the most sympathetic and helpful spirit. And on the other hand, the extension workers, whatever the distance that separates them from headquarters, must fully realize that they are essential parts of the institutions they locally represent and must be thoroughly imbued with a spirit of loyalty to these institutions and an attitude of broad and intelligent appreciation of the functions of administrators, teachers and investigators at the colleges and the department. There must be no carping criticism of the theoretical *vs.* the practical as if these are inevitably to be set one over against the other, but a generous recognition that in order to do our best work for the advancement of agriculture and home economics, we must know both the real facts as determined by observation and experience and also the principles on which these facts

are based as determined by reason and investigation.

The man in the field must constantly bear in mind that he owes what he has to demonstrate very largely to the patient labors of the investigator and the clear and orderly exposition of the teacher. And the man in the laboratory or the classroom must do his work with the consciousness that what he discovers or teaches will speedily and broadly be put to the test of actual trial in the field.

Some have feared that the wide expansion of the extension work with its accompanying great popularity would break down the thoroughness of investigation and the solidity of teaching in our agricultural institutions. Without doubt there is grave danger of evil effects of this character due to the very rapid enlargement of the extension service. As long as the supply of properly trained men is far below the demand that branch of the service where the demand is most urgent is likely to profit at the expense of the other branches. A great popular movement like the present insistence on the wide dissemination of agricultural knowledge is likely to have a torrential influence and sweep many men off their feet and even institutions off their foundations. But such floods are short-lived. After they subside it is often possible to accomplish greater things than were feasible before they came.

For a time we may expect that our agricultural institutions will be so busy establishing the extension system on a grand scale that they may seem to be, and in some cases may actually be, neglectful of the best interests of their research and teaching divisions. And the public will hear and think comparatively little of any of their work except the extension service. But no sooner will the extension service be well established than it will be apparent that it can not do what its enthusiastic propagandists have led the unthinking multitude to believe it would straightway accomplish. Here and there will be great and striking results due to peculiar conditions. There may even be some steady progress in agricultural betterment over wide areas. But in the main important immediate changes in agricultural practise will be relatively few and general advancement will be slow. The reasons for this will be many and complicated. But two important things affecting our agricultural institutions will be apparent.

First it will be clear that to many of the agricultural problems which the extension men will encounter in their work among the farmers, no solution or at best a very imperfect solution is now available. The limitations of our knowledge will be more and more apparent as this knowledge is widely put to the test. The need of further investigation along many lines will therefore become clearer and the demand for it will be much more widespread and insistent.

Secondly, it will not be long after the extension force is expanded to the extent permitted by available funds before the defects in the training of the field men and women will be clearly revealed. A goodly number of those who will enter with great enthusiasm on this service will shortly be actually "prophets without honor in their own country," not so much because the people are blind to their interests as because these prophets have not foretold the things that should come to pass. In some cases this will be because the extension agents have not properly improved existing opportunities for training and have gone on presumptuously without regard to their ignorance. But in most cases these agents will be deeply conscious of their own lack of knowledge and regretful that they have not been better prepared for this special service. And even those who have had the best training and experience and are most successful in their work will have a keen sense of their limitations and will realize the defects of their training. We may therefore expect a demand for better teaching at our agricultural colleges from two sources, (1) from the people for whose benefit the extension service is established and (2) from the workers in that service.

The development of the extension service will therefore put an additional responsibility and burden on the teaching force of our col-

leges. This is already overburdened by the rapid increase in the number of students. Under existing conditions this increase will grow larger at an accelerating rate, for the people are just beginning to realize the value of an agricultural education. It is very important that the colleges should seriously consider the situation confronting their teaching departments with a view to adjusting them to the new demands. For it is clear that the agricultural colleges must soon reach a decision as to what grades of teaching they will undertake and what they will leave to other agencies to perform. It is clearly their duty to provide thorough and ample courses of study for those who are to become investigators, teachers in secondary and collegiate institutions, extension workers, federal and state officials, managers of large enterprises directly or indirectly connected with agriculture, and those farmers who are desirous of thorough college training as a preparation for following the art of agriculture.

On the higher and more technical side of agricultural education greater attention is urgently needed to develop strong collegiate courses with ample specialization for various purposes and graduate instruction of the best type. On the other hand the flood of short courses which has so rapidly increased in amount and variety in recent years must be stemmed and plans must be definitely made for diverting this into channels outside the college. No doubt these courses have served a very useful purpose but the situation with regard to them is wholly different from what it was at their inception or even a few years back. Agricultural education is now a great universal demand and will be much more generally sought when the extension system is well under way. Much more must be done, and done as quickly as possible, to provide schools in the local communities which can take care of the great mass of students who desire only elementary and fragmentary instruction in agriculture. Well-trained and experienced teachers, capable of giving thorough collegiate and graduate instruction, are not so numerous that we can afford to use up their time and energy in giving superficial instruction to great classes of a hundred or more miscellaneous students at short winter courses or in summer schools. Where are we to get the great agricultural scholars who are to lead and inspire our college students if we do not give such men the time and opportunity to keep up-to-date in their specialties, to read, think, investigate and travel as college professors ought to? One broad effect of the new developments in the general college organization should therefore be a clearer differentiation of the collegiate teaching body and a systematic arrangement under which the problems of strictly collegiate and graduate teaching shall receive the attention which they deserve. Obviously many things are now being done in the regular college courses in agriculture which should be turned over to the secondary schools and other things which should be relegated to the extension divisions. There is plenty of opportunity for a better pedagogical standard, better laboratory and field exercises and equipment, more satisfactory text-books, manuals and illustrative material for work in the higher ranges of agricultural instruction.

Not only is there need for more attention to the perfecting of the collegiate courses of instruction for the general body of agricultural students, but special attention should be given to courses for the training of teachers for the regular work of the colleges, for extension work, and for secondary schools. As regards extension work this need is now very urgent. The demand for secondary teachers of agriculture is also growing apace. The constantly broadening interest in vocational education is sure to bring a far greater demand on the land-grant colleges for the training of teachers, not only in agriculture, but also in the trades and home economics. The National Commission on Vocational Education made the following reference to this subject in its recent report to Congress. H. R. Doc. 1004, 63d Congress, 2d session, p. 43.

> We can not rightly undertake a program of practical education in this country and carry it through successfully without teachers properly

qualified by training and experience for their work and with practically no facilities for their proper training in the future.

Here and there are schools which have rendered good service by equipping instructors in manual training, but it is safe to say that at the present time not a half dozen schools exist in the United States which afford an adequate opportunity to secure thoroughgoing preparation for the teaching of trade and industrial subjects. Excellent as has been the technical preparation which the state colleges of agriculture and mechanic arts have given to their students, many of them have not as yet developed departments of education adequate to the task of training prospective teachers either of agriculture or the mechanic arts in the administrative and teaching problems of the vocational school. The comparatively poor support given to this feature of their work by some of the agricultural and mechanical colleges is shown by the fact than out of an appropriation of more than $2,600,000 made to them by Congress under the Match and Nelson Acts for the year 1912–13, these colleges spent less than $34,000 "for the preparation of teachers in the elements of agriculture and mechanic arts."

In their teaching departments the agricultural colleges do not need any longer to bid for great numbers of students. The problem rather is to determine more definitely than hitherto what classes of students the colleges should undertake to train and then to use their available funds in providing the most efficient courses of instruction to meet the requirements of such students. The colleges can now greatly aid in the proper development of the general system of education in agriculture and other vocational subjects, which sooner or later will permeate our public school system, by assuming more strongly a policy of exclusion as regards students not qualified to profit by college instruction. Much needs to be done to correct a widespread popular notion that these colleges ought to do all that is necessary for the state to do as regards the teaching of agriculture and other vocational subjects. Unless the colleges themselves cut out these features of their present work which are really outside their province and devote themselves more strongly to those things, such as the preparation of investigators, teachers and extension workers, which should permanently constitute their chief functions, they will subject themselves to increasing criticism from the more intelligent body of their constituents. They will also surrender some of the highest privileges of leadership in the great educational movement now in progress in this country.

This association has been greatly interested in the promotion of graduate study in agriculture and has practically shown this interest by the maintenance of the biennial short-term graduate school of agriculture, the last session of which was successfully held at the college of agriculture of the University of Missouri. Some of our colleges have made a good beginning of regular graduate courses. Others are not yet in a position to undertake such courses in a satisfactory way. May it not be the duty of this association to take up this matter more thoroughly and through its standing committee on graduate study extend the cooperative efforts of the colleges to provide graduate courses for all students through the country who are qualified to pursue them? There certainly should be soon a number of centers of graduate study in agriculture in the United States which will be broader in scope and more thorough in equipment and teaching than any the world has yet seen. Travel and study abroad will always be beneficial to a certain extent for persons aiming to become experts but the United States should have graduate schools of agriculture which will not only be thoroughly satisfactory to her own students, but also highly attractive to those of other countries. We can not be content as long as any considerable number of our agricultural investigators and college teachers have had only an undergraduate course. Under existing circumstances these men should be encouraged in every possible way to extend their studies after they enter the employ of our agricultural institutions. But stronger efforts should also be made to encourage the taking of graduate courses before entrance on active professional careers. And the bars of entrance to research or teaching positions in our colleges and the department

should be steadily raised until our agricultural institutions in this respect are on a par with first-class higher institutions of learning and research in this and other countries.

The events of the past year are also destined to have far-reaching effects on the work of our institutions devoted to agricultural research. The great expansion of extension activities will inevitably lead to much more varied demands for research. The more the extension workers and to a considerable extent the agricultural people with whom they work, come to realize that our present knowledge will only go a little way toward solving the multitudinous problems of agriculture the more widespread and insistent will be the demand for more numerous and thorough investigations of these problems. It is therefore very important that we should consider the actual status of our research institutions and, while rejoicing in their many good features and their valuable work, should be active in remedying their deficiencies and enlarging their services.

So far our agricultural experiment stations and Department of Agriculture have been hampered in their research work because of the varied duties imposed on them outside of their research functions and the lack of proper differentiation of lines of work and personnel. The department is now alive to this deficiency and under the plans for reorganization undertaken by Secretary Houston aims to make a distinct separation between research, extension and regulatory activities. It will thus be possible to know what funds, equipment and force the department actually has for research, to determine definitely what problems it will attempt to solve, and to put a more rigid responsibility on its research workers to formulate good plans and to hold to their work on the chosen projects until something worth while is accomplished. If adequate supervision of the research work of the department is provided this plan should result in better and more productive research.

The closer relations of the agricultural experiment stations with the department under the new arrangement for comparison of projects and for publication of results in the *Journal of Agricultural Research* should also be a great stimulus to both the state and national institutions to improve the character of their research undertakings.

Meanwhile a private organization with large resources is planning to undertake agricultural research on a scale commensurate with that on which research in other lines has been successfully prosecuted by similar agencies. The friendly rivalry of a great private institution in this field ought to prove very beneficial to our public agricultural institutions.

In a general way our agricultural research is at present too diffuse. We have too large a number of projects for the funds devoted to them. If this private institution follows the course pursued by similar institutions in other fields and concentrates its efforts on a few large undertakings it may serve to aid our public institutions to change their policy in this direction. We have been so desirous of meeting the numerous demands for experimental inquiry and so ambitious to cover the whole field of agriculture that we have so far permitted the undertaking of too many small investigations and very generally with unsatisfactory results.

Recently a public discussion has arisen on the question whether it is better to have research institutions separately organized or connected with colleges or universities. From the standpoint of agricultural research this discussion is timely. At the dedication of the Marine Biological Laboratory at Woods Hole, Mass., President Woodward of the Carnegie Institution pointed out some of the weak points in the present attitude of educational institutions toward research.[2]

. . . It is often assumed that research is a harmless and a fruitless diversion in the business of education, and that it requires but a portion of the leisure time of those chiefly occupied with duties of instruction and administration in colleges and universities. On the other hand, some eminent minds maintain that serious and fruitful research can be advantageously pursued only in connection with work of instruction, while a few

[2] SCIENCE, August 14, 1914.

enthusiasts go so far as to suggest that the mental and bodily vigor of an investigator can be conserved only in the stimulating presence of immature minds, otherwise known as students or candidates for higher academic degrees. Such eminent minds and enthusiasts entertain grave doubts as to the propriety of the existence independently of colleges and universities of research establishments. It is darkly hinted, indeed, that the latter may work harm, if not ruin, to the former by enticing the effective teacher away from his students and by checking the diffusion in order to promote the advancement of knowledge. . . .

. . . While it is quite true that a majority of the fundamental researches of the past have been accomplished by individuals and that they will continue to be so accomplished in the future, it should nevertheless be the primary purpose of a research institution to institute and to conduct research; to take up especially those larger problems not likely to be solved under other auspices, problems requiring a degree of organized effort and a continuity of purpose surpassing in general the scope and the span of life of any individual investigator. . . .

. . . They should recognize that the ends of research are not limited to the highly worthy object of fitting candidates for the doctorate degree; and they should recognize that there is the amplest room for the simultaneous existence of educational institutions along with other organizations whose primary purpose is not the diffusion but the enlargement of learning. . . .

. . . Research and research organizations are somewhat in danger of being swamped by an excess of symbiosis. . . . Instead of following precedent, we should in general avoid it. When, for example, a research fund is established we should not make haste in academic fashion to set up poor-boy scholarships and reviving fellowships to be awarded to the amateur and to the tyro, but we should seek to originate and to conduct research under the auspices of competent and responsible investigators. And as regards research in academic circles, we need to fix attention rather on the professors who are qualified to extend the boundaries of knowledge than on their pupils. These latter, if worthy of the name, will require little formal instruction in the presence of evolving discoveries and advances; moreover, they must learn early to think with their own hands if they may hope to become either competent teachers or leaders in work of research.

Dr. Woodward's suggestions are further elaborated by Professor W. E. Castle of Harvard University in SCIENCE, September 25, 1914.

. . . Our larger universities, and many of our smaller ones too, point with pride to the research work which they are accomplishing. But in not a few cases this work, if inspected carefully, is found to take final shape in dissertations for the doctorate, of doubtful value as contributors to knowledge, prepared primarily not because the author had something of value to record but because he had to record something in order to get the coveted degree.

The chief energies of many professors entirely competent as investigators are wholly absorbed in laboriously dragging candidates through the academic mill up to the final examination for the doctorate. Their success as research professors and the standing of their universities as centers of research is commonly estimated in numbers of doctorates conferred. . . .

The attempt to combine teaching with research has another indirect but evil consequence. The periods which the professor can himself devote to research are intermittent and fragmentary. This affects disadvantageously the topics selected for investigation. They too must be minor and fragmentary. Great fundamental questions requiring long continued and uninterrupted investigation can not be attacked with any hope of success by one who has only an occasional day or a summer vacation to devote to research. The necessity too, of hunting up thesis subjects for students, small enough in scope to be handled successfully by a beginner in a limited time and yet novel enough to make a showing of originality reacts unfavorably on the professor's own work. It loses both in breadth and depth. He who in the full maturity of his powers should be doing a day's work, runs errands for boys, holds their coats and carries water. Imagine what the "Origin of Species" would have been like had it been brought forward vicariously as a series of theses for the doctor's degree, each aiming to present a different point of view or a novel method of attacking evolutionary problems. . . .

The university is an entirely suitable place, in many respects the *best* place, for a research establishment; but when such establishments are founded in connection with a university, their purpose *for research* should be made very clear and their administration should be kept very distinct

from both teaching and the demonstration of discoveries to the public.

Undoubtedly both the state agricultural colleges and the Department of Agriculture are having serious difficulties in creating within themselves the proper attitude and atmosphere with respect to research. The colleges are troubled with the well-nigh overwhelming inrush of students and the innumerable calls for service in the extension fields. The department is in difficulty because of the constantly increasing pressure of its inspection work and other administrative duties and the fact that it is supported wholly by annual appropriations, money for research being considered as largely an incidental matter in the general budget. Research in both national and state institutions is also hampered by the insistent calls for immediate practical results, by the shifting of men from one institution to another without regard to the requirements of their research work, and by allurements of popular applause for striking advertisements of alleged accomplishments. The atmosphere of our agricultural institutions is surcharged with a feverish excitement. Men are hurrying about to do this or that which is supposed to be absolutely necessary to keep their students or the legislators or the farmers contented and sympathetic. Even on the scientific side there is much of distraction. New organizations are constantly being formed, new journals are being established and edited, local, state, national and international meetings are being held. Besides all these things, some agricultural scientists think it is necessary for them to engage in practical agriculture and actually manage farms or other commercial enterprises. Administrative, educational and commercial factors make up so much of the atmosphere of our agricultural institutions that those gentle and highly intellectual influences which are needed to inspire real research are apt to be felt but weakly in the body corporate. The *great* problem, then, is how to make such influences so highly intensive that they will be felt above all the others. For only in this way can we hope to make the research work of our public agricultural institutions so efficient that its results will be an adequate foundation for the administrative and educational functions of these institutions and for the permanent prosperity of our vast agricultural business.

Research is not merely an incidental function of our agricultural colleges. It is under the law a necessary part of their business, and they have large amounts of public money which can be lawfully spent only for this purpose. But beyond this it is fundamental and essential to their success in teaching and extension work. They are therefore under the greatest obligations to create within themselves the atmosphere and conditions most favorable to successful research and to make sure that their research workers can give undivided attention to their investigations.

Words of friendly criticism may be as silver but far better are golden words of encouragement. And there are many of these which might be fitly spoken on an occasion like this. It will be thirty years next July since a little band of educators, scientists and public officials met in Washington at the call of the Commissioner of Agriculture to discuss the needs of the department and colleges of agriculture and their mutual relations. This proved to be the beginning of this association.

Agriculture in the United States was then a depressed and neglected industry; agricultural investigators, teachers and students were very few, and the Department of Agriculture was chiefly known as a seed-distributing agency. Behold how much has been accomplished in three decades, less than a single generation. A great system of agricultural research has been developed within the department and the states and this is found in organized form in every state and all our outlying territories. So much definite agricultural knowledge has been accumulated that strong and broad agricultural courses have been established in the colleges with the result that they are thronged with agricultural students. The practical outcome of the investigations of the department and the stations and the teachings of the college has been so far beneficial to our agriculture that agricultural education is no longer

confined to our colleges but is now pursued by thousands of students in special and ordinary secondary and elementary schools. And this movement is rapidly growing. Our adult farmers are so desirous of securing the information which our agricultural institutions have to give that many millions of copies of department and college and station publications are annually distributed, the farmer's institutes last year had an attendance of over 3,000,000, and a comprehensive system of agricultural extension service is rapidly covering the whole United States. And now has come this new union of the national and state and local forces for the dissemination throughout our vast territory in a practical way of whatever knowledge our research and educational agencies have accumulated or will gather in the future. And this comes at a time when all classes of our people, in both city and country, are alive as never before to the fundamental importance of our agricultural industries and the absolute necessity of having contentment and permanency in our rural communities.

All will acknowledge that the national and state institutions represented in this association have individually and collectively rendered service of great value to the republic in the past thirty years. But who will venture to set the limits of their achievements in the next thirty years? Certainly the program which they have set for themselves should be a great inspiration to all who serve in their ranks. They have defined agricultural research and education in terms broad enough to take in the multitudinous variety of production in agricultural regions which stretch from the arctic circle to near the equator, as well as a wide range of economic and social problems connected with the business of farming, the life of the farm home and the activities of the rural communities. The extent and variety of the subject-matter to be studied and taught would in themselves be powerful incitements to strenuous intellectual endeavors. When to these are added the vast extent of our territory and the tremendous number of our people the human interests involved make a powerful appeal to our emotions. And finally the complicated administrative machinery which we are developing for this agricultural service, in harmony with the American interlocking system of national, state and local jurisdictions, will require the exercise on a grand scale of combined energy and self-restraint which are the most marked characteristics of the will power of the modern civilized man. If what we call cooperation, fraternalism, or any other name designating united, harmonious and effective activity of groups of people, is to be the governing principle of community, national and international life in the years to come, it may have the finest exemplification in the activities of the institutions represented in this association. And this as I understand it is the example which we are proposing to show to the world. The very difficulties of the scheme are alluring to us and the more we imbibe the spirit of this undertaking the more we are convinced that we can make it a success.

A. C. True

INTERGLACIAL MAN FROM EHRINGSDORF NEAR WEIMAR

The attention of prehistoric archeologists has long been turned toward the region of Weimar, Germany, because of important discoveries made at Taubach and Ehringsdorf, both in the Ilm Valley. Known since 1871, the station of Taubach (back of the village of that name) was systematically explored between 1876 and 1880. The deposits at Taubach and Ehringsdorf are alike. Their basis is a layer of sand and gravel dating from the third or Riss glacial epoch (Obermaier). Above this is lower travertine with remains of the mammoth and woolly rhinoceros near the bottom, and those of *Elephas antiquus* and *Rhinoceros merckii*, both witnesses of a warm climate, near the top. Next above at Ehringsdorf comes the so-called "Pariser" (corruption from Poröser) deposit, a sort of loess. Higher still is a deposit of upper travertine with remains of the stag and woolly rhinoceros; curiously enough the *Rhinoceros merckii* also occurs at this level.

The human remains in question, consisting of a nearly complete human lower jaw, form the subject of a paper just published by Professor G. Schwalbe[1] of Strassburg. Professor Hans Virchow was to have given a demonstration of the specimen before the German Congress of Anthropology at Hildesheim last August, but the congress was not held on account of the war. The discovery was first brought to my attention through a letter from Dr. L. Pfeiffer, of Weimar, under date of July 20, 1914. Like much of the archeological material previously found at Taubach and Ehringsdorf this lower jaw is now the property of the museum at Weimar. Because of its double association with that city, Schwalbe proposes to call it the Weimar lower jaw.

The lower jaw was found on May 8, 1914, at a depth of 11.9 m. below the surface in the lower travertine, 2.9 m. below the so-called Pariser loess. It is from the Kämpfe quarry at Ehringsdorf and was brought to light by means of a blast. Under the circumstances it was fortunate indeed that the lower jaw suffered no worse. All the teeth are intact and in situ save the two right incisors (in their place is a small mass of travertine containing a univalve shell). Both halves of the body are practically complete. The right ascending ramus is in part present; although not enough remains to save the mandibular angle, the coronoid and condyloid processes, and the mandibular or sigmoid notch. The left ascending ramus is completely gone.

A number of remarkable features are combined in the Weimar lower jaw. The absence of a chin is doubly emphasized because of the pronounced alveolar prognathism as shown in the figures, a condition not found in the lower jaws of Krapina and La Chapelle-aux-Saints, nor even in that of *Homo heidelbergensis.* Closely related to the alveolar prognathism is the sloping nature of the inner surface of the jaw in the region of the symphysis, region called by Schwalbe planum alveolare. In all other lower jaws of the Neandertal type a median line in this field is much more nearly vertical. Below this planum alveolare is a spinous area but no distinct spines for the attachment of the genioglossal and geniohyoid muscles. Neither is there the customary ridge on the inner surface of each corpus for the attachment of the mylohyoid muscles. The absence of this mylohyoid ridge is even more marked than in the well-known mandibles of the Neandertal type.

The foramen mentale is unusually large. It is directly beneath the first molar (similar to the situation in *Homo primigenius*); while in recent man this foramen is located farther forward beneath the second premolar. In the Heidelberg lower jaw it is also large but situated further forward than in the specimen from Weimar.

Schwalbe lays special stress on the narrowness of the arch of the Weimar jaw. The breadth between the inner faces of the third molars is 48 mm.; the distance from posterior surface of the third molar to the anterior margin of the median incisor is 69 mm. The index derived from these two measures in the chimpanzee is 54.6. In the Weimar jaw this index is 69.5; while it is much larger in other known fossil human lower jaws: Heidelberg 75.7, Krapina 80 and La Chapelle 100. Schwalbe admits however that the low index of the Weimar jaw might be due in part at least to post-mortem deformation.

The teeth are much worn. Since the premolars are less worn than the canines, one is led to conclude that the points of the canines stood above the level of the premolars. There is no diastema between the canines and the first premolars. A notable feature is the relative smallness of the third molars. This unexpected condition proves that the tendency of the third molars to disappear is of much more ancient origin than other known jaws of the Neandertal and earlier types have led us to suppose.

Without hesitation Schwalbe places the Weimar lower jaw in the Neandertal group, for which group he proposed some years ago the name *Homo primigenius.* In the preliminary paper he does not describe the cul-

[1] "Über einen bei Ehringsdorf in der Nähe von Weimar gefundenen Unterkiefer des *Homo primigenius,*" *Anat. Anzeiger,* Band 47, 337–345, 1914.

tural remains found at the same level. He does however mention some of the numerous accompanying fauna: *Rhinoceros merckii*, stag, horse, ox and cave bear. There was also an abundance of charcoal and flint implements, the latter for the most part apparently retouched points and scrapers.

Two human teeth (one of a child and one of an adult) had already been found in the lower travertine of Taubach. During the summer of 1908, Dr. Pfeiffer found human skull fragments in the same deposit at Ehringsdorf.

Both Obermaier and Schmidt consider the lower travertine of Ehringsdorf (the deposit in which the lower jaw was recently found) and Taubach to be older than Mousterian. Although it contains no typical coups de poings, on account of the character of the fauna as well as the industry, Obermaier would call the deposit of Chellean age. For Schmidt, who has recently published examples of the industry, it is Acheulian.

In any case all are evidently agreed that the deposit belongs to the Riss-Würm interglacial epoch. In that case according to one school it might be Chellean, Acheulian, or early Mousterian; according to the school of Penck, it would have to be later Mousterian, since he places early Mousterian during the Riss glacial epoch and the Chellean-Acheulian during the second or Mindel-Riss interglacial epoch.

Whichever view is correct, on account of its anatomical characters, as well as the position of the deposit and the nature of the associated cultural and faunal remains, the anthropologist may justly claim for the Weimar lower jaw an antiquity surpassed perhaps only by the skull of Piltdown and the Mauer (*Homo heidelbergensis*) lower jaw.

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THE CHICAGO MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences will meet December 7, 8 and 9 at the University of Chicago. Social headquarters will be at the Quadrangle Club, 58th Street and University Avenue, where the members will meet for the first time December 7, 1:00 P.M., for luncheon. A feature of the meeting will be the second course of William Ellery Hale lectures on evolution, two lectures by Professor William Wallace Campbell, director of the Lick Observatory, on Stellar Evolution and the Formation of the Earth. These lectures and four sessions with papers by members of the academy and others will be open to the public.

The council will meet at 4:30 P.M., December 7, at the Quadrangle Club.

A preliminary program of the scientific papers is as follows:

I. *Mathematics*

Gilbert Ames Bliss: *A Generalization of a Theorem of Gauss Concerning Geodesic Triangles.*

If a line OA of unit length is parallel to the normal at a point a of a surface S, then A may be regarded as the image of a on the unit sphere with center at O. It is a theorem due to Gauss that the difference between π and the sum of the angles of a geodesic triangle on the surface is numerically equal to the area of the image of the triangle when each point is mapped on the sphere as above described. The paper is concerned with a generalization of this theorem. The magnitudes involved in the statement of the theorem, angles, the equations of the geodesic lines, the area of the image of the triangle, are expressible in terms of invariants associated with the integral of length on the surface S. For a more general integral of the calculus of variations some of the analogous invariants have been found by the author and other writers. In the present paper the remaining invariants are described, and a theorem corresponding to that of Gauss is deduced.

Leonard E. Dickson: *Recent Progress in the Theories of Modular and Formal Invariants.*

Contrast between algebraic and modular invariants. Formal invariants and their construction. Modular plane curves for modulus 2.

G. A. Miller: *The ϕ-subgroup of a Group of finite order.*

In 1885 Frattini introduced the ϕ-subgroup of a finite group G as the characteristic subgroup whose individual operators enter into no set of

independent generators of G. In the present investigation the ϕ-subgroups of various important groups G are studied,—in particular, of groups of order the power of a prime, of direct product groups, of abelian groups, of the Sylow subgroups of the symmetric group on n letters. Two of the principal results are: (1) The ϕ-subgroup of a Sylow subgroup G of the symmetric group on n letters is the commutator subgroup of this Sylow subgroup G. (2) The various sets of independent generators of a group G of order the power of a prime contain the same number of generators, so that this number is an invariant of the group G.

ELIAKIM H. MOORE: *On the Integration by Successive Approximations of the Ordinary Differential Equation of the First Order in General Analysis.*

The classic problem of integration of a simultaneous system of n ordinary differential equations of the first order may be expressed as follows: To determine the n-partite number or point $\xi = (x_1, \cdots, x_n)$ in n-space S_n as a function of the real variable t in such a way as to satisfy the differential equation

$$\frac{d\xi}{dt} = K(t, \xi)$$

with the initial condition:

$$\xi(t_0) = a = (a_1, \cdots, a_n).$$

Here for every t of a certain interval T' of the real number system T and point ξ of a certain region S' of S_n. $K(t, \xi)$ denotes a point of S_n; t_0 lies within T'; a lies within S'; and K satisfies the continuity and Lipschitz conditions. A point ξ may be thought of as a function of i; $\xi(i) = x_i$ $(i = 1, \cdots, n)$. If in this problem we replace systematically the special variable i with the special range $i = 1, \cdots, n$ by a general variable p with the general range P we obtain the corresponding problem in general analysis. Then by imposing suitable conditions on S', K and a we validate for the general equation with initial condition the process of integration by successive approximations. The general treatment covers the classical case and, for example, certain types of infinite simultaneous systems of differential and of integro-differential equations.

F. R. MOULTON: *An Extension of the Process of Successive Approximations for the Solution of Differential Equations.*

With the exception of the Cauchy polygon process, which is not of practical value, the existing methods of solving differential equations have, in general, only a limited domain of applicability. The processes defined in this paper apply to a very general class of differential equations, they are convenient in practise, and they furnish the solution with any prescribed accuracy in an arbitrary part of the domain of its existence. The range on the independent variable for which the solution exists is not known in advance, but the process enables one to determine when he is safely within that range.

H. S. WHITE: *The Synthesis of Triad Systems Δ_t in t Elements, in Particular for $t = 31$.*

This note reviews earlier and recent studies in triad systems, and signalizes one advance step. The field is largely unexplored, and progress requires study of specimens and induction. Twenty-three specimens of Δ_{15}'s showing odd and even structure, many new, are available in Miss Cummings's dissertation (Bryn Mawr, 1914); and one of different structure, headless. Upon these one new theorem is verified, then demonstrated, relating t with $2t + 1$. This makes possible the precise enumeration of Δ_{31}'s of odd and even structure which can be compounded from a headless Δ_{15} and any other. Headless systems (yet unpublished) prove the resulting Δ_{31}'s to number above 14!

E. J. WILCZYNSKI: *Conjugate Systems of Space Curves with Equal Laplace-Darboux Invariants.*

It is well known that four linearly independent solutions of a linear differential equation of the form

$$\frac{\partial^2\theta}{\partial u\,\partial v} + a\frac{\partial\theta}{\partial u} + b\frac{\partial\theta}{\partial v} + c\theta = 0$$

determine a surface upon which the parametric curves form a conjugate system. A great deal of work has been done upon the special case when the Laplace-Darboux invariants of the equation are equal to each other. The geometrical significance of this condition, which up to the present time seems to have escaped notice, is the object of Mr. Wilczynski's communication.

II. *Astronomy*

E. E. BARNARD: *Explanation of Certain Phenomena of the Tail of Comet Morehouse* (III., 1908).

Within certain limitations, there is nothing so wonderfully effective for the study of cometary phenomena as the stereoscope. The author has applied this method for the study and explanation of the remarkable phenomena of the tail of

Morehouse's comet on October 15, 1908. A good series of photographs of the comet was obtained on that date in this country and in Europe, the earliest of these being made at Geneva, Switzerland. The photographs made at the Yerkes Observatory (continuously) on that date with the Bruce telescope extended from 6^h 18^m to 13^h 28^m C. S. T., or for a period of 7^h 10^m. A set made in France, another in England, and two sets obtained by the author with the Bruce telescope of the Yerkes Observatory, are available for stereoscopic combination. It is from the study of these combinations that the following simple explanation of the phenomena is derived.

The photographs all show a twisted appearance of the tail about ½° from the head, apparently joined to the head by a slender straight beam. The broken part of the tail became more disrupted, and changed more rapidly in the later photographs, until it formed a broad mass with a broad tail. A study of the stereoscopic views shows what really happened. At a time earlier than the first photograph the comet had discarded its tail (by ceasing abruptly to emit matter in that direction) which drifted away into space. For some reason, perhaps from a disturbance due to the cessation of emission at that point in the comet's head, the rear end of the receding tail "buckled" and became twisted into a spiral which finally formed an irregular ring—very much like the smoke ring familiar to the users of tobacco. Every part of this condensation ring sent out a continuous stream of matter until it formed, roughly, a long open cylindrical tail to the ring, with one end pointed more or less towards us.

This last phase of the disturbance was the condition of the tail at the time of my last photographs of that night. By the next day the remnant of the discarded tail had drifted farther away and had become so changed as to be of little interest in connection with its form on October 15. The slender beam of light that apparently connected this phenomenon with the head was really a new tail which was forming and which did not touch the masses in the old tail but passed behind them, at a considerable angle as shown by the stereoscope.

W. W. Campbell: *On the Radial Velocities of Nebulæ.*

The radial velocities of 54 planetary and ring nebulæ and nebulæ of irregular form, have been determined at the Lick Observatory and at the D. O. Mills Observatory in the past three years by spectrographic means. The nebulæ are remarkable for their high velocities. Only a fifth of the radial velocities are less than 10 km. per second, there are 9 radial velocities greater than 60 km. per second, and the average for the 54 nebulæ is 42 km. per second. This is 7 times the average radial velocity of the so-called helium stars, which have generally been supposed to be the stars most recently evolved from nebulæ. Omitting 12 extended and ring nebulæ, the average radial velocity of 42 planetary nebulæ is 46 km. per second. Two nebulæ, close together in the sky, have been observed as 202 km. per second recession and 141 km. per second approach, respectively,—a relative radial motion of 343 km. per second.

The prevailing high velocities of planetary nebulæ make difficult the continued acceptance of Sir William Herschel's view that the planetary nebulæ evolve into stars [whose speeds are of average dimensions]. On the contrary, there is some basis for the suggestion that the planetary nebulæ have been formed from the rushing of high-velocity stars through resisting media in space. Rapidly-moving stars are the ones which would have the greatest chance to encounter resisting media, and the collisional or bombardment effects would be the more effective in generating nebular condition the higher the velocities of impact.

Heber D. Curtis: *Preliminary Note on Nebular Proper Motions.*

Knowledge of the distances and linear dimensions of the nebulæ are important in studies as to the nature of the nebulæ themselves, and especially as to their relation to the stellar system. It is desirable, therefore, that every opportunity be utilized to determine the proper motions of the nebulæ.

Professor Keeler's program of nebular photography with the Crossley Reflector of the Lick Observatory was inaugurated in 1898, continued by him into 1900, and in the next few years completed by Professor Perrine. A new series of photographs of the same objects, with the same telescope, was begun last winter and should be completed in the early summer of 1915. About one third of the proposed photographs have been obtained to date, and nearly all of these have been compared, as to the accurate positions of nebular nuclei and other very definite masses of nebular structure, with the photographs of the same objects secured from twelve to sixteen years ago. If any motions of translation or rotation in the

objects re-photographed have occurred in the interval, these changes seem not to be appreciable, or at most, are exceedingly small. The conclusion drawn from this fact is that the nebulæ concerned are very remote, and therefore are enormous in linear dimensions. These provisional conclusions apply to many of the large irregular nebulæ, such as the Orion and Trifid nebulæ, and to many of the more prominent spirals, including the great spiral in Andromeda.

EWDIN B. FROST: *An Interesting Stellar System.*

Observations have been continued on the spectroscopic binary β Cephei, which has the remarkably short period of 4^h34^m. Some features of the system are discussed, and reference is made to the detection at Berlin of variations in the star's brightness by the photo-electric method.

GEORGE E. HALE: *The Direction of Rotation of Solar Storms.*

It is well known that cyclones and tornadoes in the earth's atmosphere rotate in the right-handed (clockwise) direction in the southern hemisphere and in the left-handed direction in the northern hemisphere. What is the case for solar storms?

The existence of a magnetic field in sun-spots, supported by other spectroscopic evidence, proves that sun-spots are electric tornadoes of immense size. The direction of rotation of the spot-vortex is given by a simple spectroscopic observation.

The results were at first confusing, as spots rotating in both directions were found in the same hemisphere. But it soon appeared that sun-spots usually occur in pairs, lying close together on a nearly east and west line, and always having opposite directions of rotation. Tabulating the polarities separately for the eastern (following) and western (preceding) members of bipolar pairs, we find (with very few exceptions) that the directions of rotation for preceding or for following spots are opposite in the northern and southern hemispheres.

Prior to the recent sun-spot minimum the preceding spots of the old cycle rotated left-handedly in the northern and right-handedly in the southern hemisphere, as in the case of terrestrial storms. Since the minimum the direction of rotation has been reversed. But the spots of the old cycle were all in low latitudes, while those of the new cycle are all in high latitudes. Thus there probably exist in each hemisphere a high latitude zone, in which preceding spots rotate right-handedly in the northern and left-handedly in the southern hemisphere, and a low latitude zone, where preceding spots rotate left-handedly in the northern and right-handedly in the southern hemisphere.

J. C. KAPTEYN AND W. S. ADAMS: *On the Relations between the Proper Motions and the Radial Velocities of the Stars of the Spectral Types F, G, K and M.*

(1) The radial velocities furnish a very thorough test of the theory of the star streams. The results found for the F, G, K and M stars are in close agreement with those we should expect from the theory as derived from proper motions. (2) The radial velocities of the stars of the smallest proper motions show the effects of the two star-streams with the same certainty as those of the other stars. The existence of the two star-streams is, therefore, proven at the greatest distances for which we have adequate data. (3) The K stars behave in general like the other stars, but there are a few exceptional cases. These do not appear to be due to the absence of the second stream. (4) For all of the spectral classes the average radial velocities show a regular increase with the proper motion. (5) Such a change of radial velocity is a necessary consequence of a velocity distribution (for the peculiar motions) different from that given by Maxwell's law. (6) A first approximation to the velocity distribution has been derived for the K stars. It explains the change of velocity with proper motion in a satisfactory manner. (7) Some positive indications have been found of a change of radial velocity with absolute magnitude, the brighter stars moving more slowly than the fainter stars.

S. B. NICHOLSON: *Discovery of a Ninth Satellite of Jupiter.*

A satellite of Jupiter was discovered by means of photographs made with the Crossley Reflector of the Lick Observatory on July 21 and 22, 1914. These photographs were secured in order to determine positions of the eighth satellite, and the new object was in the same photographic field. The ninth satellite is considerably fainter than the eighth, being estimated at about the nineteenth magnitude. Additional observations of the new satellite have been secured in August and September. The preliminary orbit, computed under Mr. Leuschner's direction, shows that the orbital motion is retrograde, that the first estimate of the period is approximately three years, and that the other elements of the orbit are similar to those of the eighth satellite.

C. T. KNIPP: *Experimental Data on the Stability of Positive and Negative Ions.*

In an investigation by Dr. O. H. Smith and the writer of the properties of the retrograde rays from a Wehnelt or hot lime cathode, it was found necessary in order to make their presence known, to accelerate these rays by passage through a strong electrostatic field. The photographic method of J. J. Thomson[1] was employed.

A number of plates show anomalies as to the direction of deflection, *i. e.*, the appearance of *positive* lines with *negative* acceleration, while the same exposure shows but little or no trace of the negative lines. This is contrary to what is expected under the given conditions.

This anomaly, the appearance of positive lines on the photographic plate when the acceleration is such as to allow only negative ions to get through the accelerator into the electric and magnetic deflecting fields beyond, can be satisfactorily explained if it is assumed that the positive ion is more stable than the negative ion. In other words a negative ion loses an electron more easily than does a positive ion.

The paper in detail follows the path of the negatively accelerated ion as it issues from the accelerator and notes the possible changes that evidently take place (upon the supposition stated above) as it moves on through the deflecting fields to the photographic plate. In this way every part of the line on the photograph (*i. e.*, the straight portion as well as the parabolic portion), is satisfactorily accounted for, and hence the conclusion that the positively charged ion is more stable than the negatively charged ion.

A number of photographs showing these lines accompany the paper.

III. *Physics*

A. A. MICHELSON: *Behavior of Metals and Other Substances Near the Rupture Point.*

R. A. MILLIKAN: *The Coefficient of Slip in Gases and its Relation to the Nature of the Impact between a Molecule of a Gas and the Surface of a Solid or Liquid.*

In 1911 I brought forward a new method[2] for the very accurate evaluation of the coefficient of slip between a gas and the surface of a liquid or solid. This coefficient was shown to be equal to the quantity Al in the equation for the law of fall of a small sphere through a gas.[2] This quantity Al was in turn shown to be proportional to the slope of the line obtained by plotting $e_1^{2/3}$ against l/pa in the "droplet" method for the determination of e. The values of this slope have now been obtained with different gases and different kinds of droplets. It has hitherto been supposed from the work of Kundt and Warburg that the coefficient in question is in all cases proportional to the mean free path of the gas molecule. This conclusion is now shown to be incorrect; for the above-mentioned slopes are not only found to depend on the nature of the surface against which the gas molecule impinges when this molecule remains the same, but also upon the value of the impinging molecule when the surface is the same. These results show that in general gas molecules are not "diffusely" reflected from liquid and solid surfaces as they have recently been assumed to be by Knudsen and others.[3]

[1] J. J. Thomson, "Rays of Positive Electricity," 1913.

[2] Physical Review, XXXII., p. 382, 1911.

IV. *Chemistry*

C. W. BALKE AND GEO. W. SEARS: *The Atomic Weight of Tantalum.*

In order to determine this constant two ratios were studied, $2TaCl_5 : Ta_2O_5$ and $TaCl_5 : 5Ag$.

In the study of the ratio $2TaCl_5 : Ta_2O_5$, the tantalum chloride was hydrolyzed, using nitric acid, and the resulting tantalum oxide was evaporated to dryness and ignited. In five determinations, however, a constant weight was not obtained even after repeated ignition. A fine white deposit was found in the exit tubes of the reaction flask after each analysis showing that the oxide was being lost. An examination into the cause of this showed that the hydrochloric acid was completely removed by ignition, that the nitric acid was difficultly removed, if at all, and that tantalum oxide was lost either mechanically or by volatilization, all of which indicated that the method was unsatisfactory.

In the study of the ratio $TaCl_5 : 5Ag$, several methods involving the removal of the hydrochloric acid from the tantalum were tried but without success. The only method found satisfactory was to dissolve the tantalum chloride in an approximately 5.5 per cent. hydrofluoric acid solution and to precipitate the resulting hydrochloric acid in the presence of the dissolved tantalum. Platinum vessels were used throughout and the final end point was determined in the nephelometer.

[3] *Annalen de Physik*, Kundsen Papers, 1909–1912.

Three determinations by this method gave 181.30 for the atomic weight. From one to two days were allowed for the equilibrium to become established. A further study of this equilibrium, however, showed that from three to five days were required. A final series of determinations is now in progress.

W. D. HARKINS AND E. C. HUMPHREY: *The Capillary and Electrical Forces at the Interface between Two Liquids.*

A method which gives very accurate determinations of the capillary constant at the interface between two liquids has been devised. The method consists in a measurement of the capillary height under the special conditions which are necessary to secure accuracy. The capillary height method proves inaccurate in all cases where one of the liquids gives an alkaline reaction. For such liquids the drop-weight method may be used. This method has been adopted largely by workers in the field of colloidal chemistry, but without any use of the corrections which have now been determined. Since these corrections frequently amount to as much as 37 per cent. they should not have been neglected.

The latter method has been used to investigate the relation between the change of the surface tension and the change of the electrical potential between two non-miscible liquid phases, in order to see if the relationship is such as would be in accord with one of the theories of muscular motion. This theory is in short that in muscular motion the muscle changes from a neutral to an acid reaction, that this causes a change of electromotive force between two different phases (of the order of one volt), and that this in turn gives rise to such a change of surface tension at the neutral point as was found by von Lerch in Nernst's laboratory. The present work shows that von Lerch's results were in accord with the general theory only because of the inaccuracy of his experimental work.

HERBERT N. MCCOY: *The Solubilities of Radium Compounds as Indicated by the Solubilities of Analogous Compounds of Calcium, Strontium and Barium.*

If it be assumed that radium is the fourth member of the alkali earth group, it is to be expected that the properties of compounds of this element, other than those dependent upon its radioactivity, should be determinable from a knowledge of the properties of corresponding compounds of calcium, strontium and barium. A knowledge of the solubility relations of radium and barium compounds is of great practical importance, since the former must always be separated from large amounts of the latter in the course of the extraction of radium from minerals. A systematic theoretical study of the problem indicated the chemical and physical conditions most favorable for the separation of these elements. The theoretical predictions have been verified by experiment and as a result a new method of separating radium from barium has been found which is many times as efficient as the best hitherto known.

S. W. PARR: *The Development of an Acid Resisting Alloy for a Bomb Calorimeter.*

Coals of the Illinois type when burned in an oxygen bomb generate a mixture of nitric and sulfuric acids, equivalent to approximately 30 c.c. of 1/20 N acid. The correction called for as a result of the heat of formation of these acids approximates 100 calories. If in addition some of the metal of the bomb is dissolved, there is generated an additional increment of heat for which a correction can not readily be applied. Hence the use of platinum or gold as a lining for such bombs.

In April of 1911 the first attempt was made to produce an alloy sufficiently resistant to these acids to permit of its use in the construction of an oxygen bomb. The first successful casting was obtained in December, 1911, but this could not be duplicated until quite recently on account of the difficulty experienced in casting the metal in a dense non-porous form free from flaws.

The alloy is of the nickel chrome type with copper 7 per cent. tungsten and molybdenum from 3 to 5 per cent. The standard of reference for solubility is taken as the amount dissolved by 4 N nitric acid at room temperature per 100 sq. cm. per hour. The average amount dissolved for such unit area and time is 0.09 milligram. The original bomb has had upwards of 1,500 combustions with no indications of corrosion.

A large number of parallel determinations with a platinum-lined bomb show a full equivalent of acid as indicated by the resulting titrations. Test bars show a tensile strength of 50,000 to 60,000 pounds per square inch while a sample of wire gave a tensile strength of 124,000 pounds. Attempts to roll the metal into sheets have not been very successful, only small areas having so far been produced.

JULIUS STIEGLITZ: *Molecular Rearrangements of Triphenylmethyl Derivatives.*

The study of the molecular rearrangements of triphenylmethyl derivatives was planned to shed light on the classical rearrangements of oximes, acyl azides, acyl halogen amides, etc., and to test the author's theory concerning the nature and causes of these rearrangements. The investigation has been developed in four directions: (1) Triphenylmethylhydroxylamines, halogen amines and azides have been shown to give the same products of rearrangement. (2) Derivatives of the unsymmetrical radicles $(C_6H_5)_2(C_6H_4X)C$-, $(C_6H_5)(C_6H_4X)_2C$-, and $(C_6H_5)(C_6H_4X)(C_6H_4Y)C$- yield quantitatively the same ratio of products in the different groups as far as these have been examined. (3) Complete proof of the rearrangement of $(C_6H_5)_3$-$C{\cdot}NCH_3{\cdot}OH$ and of the course of the action has been brought—the first rearangement of the kind ever observed. (4) Rearrangement of the hydrazine $(C_6H_5)_3C{\cdot}NH{\cdot}NH{\cdot}C(C_6H_5)_3$ has been effected—the first instance of a hydrazine rearrangement of this type.

E. W. WASHBURN: *Our Systematic Knowledge of the Properties and Behavior of Solutions of Non-electrolytes.*

A satisfactory theory of solutions must first of all give us an answer to the question: What is the relation connecting the thermodynamic potential (or the fugacity, or the osmotic pressure) of a given molecular species in a solution with the composition of that solution, its pressure and its temperature? When this relation is known for any given class of solutions we are at once in a position to calculate the values of such quantities as freezing points, boiling points, vapor pressures, osmotic pressures, solubilities, equilibrium, constants, etc., for solutions of known composition; or vice versa by directly measuring the above quantities we may compute the molecular composition of our solutions and discover what reactions, if any, have taken place between the various components of the solution.

The purpose of this paper is (1) to outline and describe (*a*) the manner in which, (*b*) the extent to which, and (*c*) the conditions under which the above question is satisfactorily answered by our present systematic knowledge of solutions; (2) to state a number of the laws of solutions as formulated in terms of this theory; and (3) to present some experimental data illustrative of the quantitative agreement between theory and experiment.

V. *Geophysics and Geology*

L. A. BAUER: *Present Status of the General Magnetic Survey of the Globe.*

On April 1, 1914, the Department of Terrestrial Magnetism of the Carnegie Institution of Washington had completed the first decade of its existence. One of the first tasks undertaken was a general magnetic survey of the globe. During the period 1905–1914, 47 land expeditions to 107 different countries and island-groups, in all regions of the earth, were sent out. Magnetic observations have been made by these expeditions at 3,000 points, extending from 80° north to 70° south. The total length of the cruises of the two vessels used in the ocean magnetic work, the *Galilee* (1905–1908) and the *Carnegie* (1909–1914), is 161,000 miles. By the end of 1916, the first general magnetic survey of the globe for the region between about 70° north and 70° south, or for about 90 per cent. of the total area, will have been completed. Satisfactory progress has likewise been made in the atmospheric-electric work. Perhaps the most important result of the observations made on the *Galilee* and the *Carnegie* is a confirmation of the somewhat striking phenomenon that, while the conductivity over the ocean is, on the average, at least as great as over land, the radioactive content is much smaller. The values of the potential gradient obtained at sea were of the same order of magnitude as those on land.

T. C. CHAMBERLIN: *The Fundamental Segmentation of the Earth.*

The paper proceeds on the assumptions (1) that the earth-body is and always has been an elastic solid, (2) that it is and always has been crystalline throughout, (3) that the specific gravity of its constituents varies appreciably throughout its mass, (4) that it grew up by accessions which varied in the velocities with which they were added and in the positions at which the additions took place, and (5) in general, that the mode of growth was that postulated by the planetesimal hypothesis. It is further assumed that the nebular knot which constituted the nucleus of the earth-growth inherited (1) a certain unknown measure of rotation from the sun, (2) that successive changes in the rate of rotation arose later from the accessions, and (3) that still other changes arose from the contraction of the mass as it adjusted itself to the stresses incident to its growth and to the progress of internal reorganization.

The segmentation discussed in the paper is assigned to changing rates of rotation, the most powerful agency of deformation to which the earth is subject. The first order of deformation under rotation, the passage from a sphere to an oblate spheroid, is passed hastily as familiar ground, save that an analysis is offered of the mode by which an earth-body of crystalline texture, affected by a concentric structure, arising from accretion, and a radial structure, arising from vulcanism, would respond to the varying stress-demands imposed by changing rates of rotation. This first order of deformation or segmentation proceeds by halves acting reciprocally, its basis being the simplest of divisors, two. The essence of the paper consists in showing that when such bipartite division is extended to the second order of segmentation it develops mechanical inadaptabilities, but that a second order of segmentation on the basis of the next simplest divisor, three, results in working adaptations. This order of segmentation gives rise to six sectors of similar form arranged symmetrically relative to the axis of rotation and alternately respecting the sectors of the opposite hemisphere. The special adaptability of this segmentation to ease the stresses that arise from changes in the rates of rotation is pointed out, as also certain causal relations that exist between these sectors and their essential parts. The surficial expression of these sectors is identified with the great physiographic features of the earth's surface.

VI. *Botany Bacteriology*

CHARLES E. ALLEN: *Development of the Male Germ Cells of Polytrichum.*

At the conclusion of the antheridial divisions, each cell contains a blepharoplast which behaved like a centrosome in the last division. This blepharoplast begins to elongate. At about the same time a large spherical body, the limosphere, appears, variously situated in the cytoplasm; later it comes to lie near one (the anterior) end of the blepharoplast. The blepharoplast is now in contact with the plasma membrane; two long cilia grow out from its anterior portion. The nucleus elongates in the same direction as, and in contact with, the blepharoplast. The limosphere divides into two bodies; the smaller remains in contact with the anterior end of the blepharoplast; the larger lies close to the posterior part of the nucleus. The nucleus becomes a long, coiled, finally homogeneous body, of about one and one half turns. The cytoplasm contains another body of variable size, often lying in a vacuole, which is recognizable from a time a little later than the appearance of the limosphere until nearly the completion of the metamorphosis of the nucleus. During this history the cell becomes first approximately spherical, then lens-shaped. The cytoplasm, aside from the special bodies mentioned, gradually decreases in amount. The body of the mature antherozoid consists of the nucleus, with a short portion of the blepharoplast, bearing the cilia, at its anterior end. The rest of the blepharoplast has become indistinguishable. Adhering to the posterior end of the nucleus, but not a part of the body of the antherozoid, are the remains of the cytoplasm, including the larger derivative of the limosphere.

CHARLES J. CHAMBERLAIN: *A Phylogenetic Study of Cycads.*

The cycads, as the only surviving family of an ancient phylum reaching back into the Paleozoic, are peculiarly favorable for phylogenetic study, and the work of others upon the Paleozoic and Mesozoic predecessors of the modern family adds to the opportunity for comparison. The nine living genera of the Cycadaceæ are confined to tropical and subtropical regions, chiefly Mexico, Cuba, Australia and South Africa, but during the past ten years all the genera and many of the species have been studied in the field, and material has been collected for a somewhat complete study of life histories. The accounts already published have dealt with cycads in the field and also with cytological details of development and have been descriptive rather than theoretical, the natural tendency to discuss the comparative morphology and phylogeny of the phylum being restrained for the present. Cytological features have proved to be more uniform and distinctive than the characteristic habit of the family.

The investigation, as it stands, adds support to the already strong conviction that the Cycadofilicales, Bennettitales and Cycadales constitute a single phylum; when completed it may throw some light upon variation, development and retrogression.

WM. CROCKER AND J. F. GROVES: *Method of Determining the Life Duration of Seeds.*

In most seeds in a dry condition the viability persists from 1 to 150 years, varying with the species. There have been several explanations offered for the loss of viability. Exhaustion of food by respiration, degeneration of digestive and

respiratory enzymes, and the others have proved out of accord with known facts. The hypothesis that loss of viability is due to a slow coagulation of cell proteins of the embryo has been proposed and is being tested out by the writers. The testing of this hypothesis is carried out by getting the life duration at any two high temperatures and using these values in the formula that expresses the relation between time and temperature for the coagulation of proteins to find the life duration at any desired temperature. As an illustration of the results, a variety of wheat with 12.5 per cent. moisture gives a calculated longevity of 9.8 years at 20° C. and 110 years at 0° C. This and other calculated values at 20° C. tallies rather closely with records of longevity in wheat. Also the calculated values at various high temperatures tallies rather closely with the found life duration at those temperatures. Two points of technique deserve special mention, the method of maintaining the constant high temperature and the method of sterilizing the seeds for germination. If the hypothesis and method prove tenable they will be of great economic significance in making possible a quantitative statement of longevity as influenced by the factors of moisture content and temperature.

Edwin O. Jordan: *Variation in Bacteria.*

An attempt is made to distinguish in specific cases between true mutations and the more or less permanent adaptive modifications evoked in bacteria by definite environmental stimuli, and to determine the relative value of each in the formation of so-called bacterial species and varieties. The effect of acclimatization upon bacteria is considered as part of the problem. Specific instances of the extent of variation in a given direction and of the plasticity of a pure line strain are also brought out.

William Trelease: *Phoradendron.*

Outline of a taxonomic revision of this genus of American mistletoes, with indication of a new basis for its primary subdivison. The paper embodies the results of a study of all of the materials in the principal American and European herbaria in the course of which almost all of the species have been photographed from the types. One fourth of the recognized species belong to a section that is found in the United States, Mexico and Central America, but is absent from the West Indies and South America; and three fourths, to a section that extends through South America and the West Indies and through Central America and southern Mexico, but is entirely absent from the United States.

Though apparently well adapted to dissemination by birds, the species are rarely of wide geographic range and in general are confined to areas limited by barriers which are effective for non-parasitic plants.

VII. *Zoology and Paleontology*

C. M. Child: *A Dynamic Conception of the Organic Individual.*

Organic individuation may be either radiate or axiate. An organic radius or axis in its simplest terms is dynamically a gradient in rate of metabolism or of certain fundamental reactions. In this gradient the region of highest rate of reaction is in greater or less degree dominant over other regions because of its higher rate of reaction and therefore influences the dynamic processes in them and determines the orderly course of development and functional relation. This dominance apparently depends primarily rather upon transmitted dynamic changes than upon transported chemical substances and the integrating action of the nervous system is its final expression. Since a decrement occurs in transmission, dominance becomes ineffective beyond a certain variable distance and the size of the individual is therefore physiologically limited. Reproduction results from the following conditions: first, physiological or physical isolation of a part from the influence of the dominant region; second, a greater or less degree of dedifferentiation or loss of its characteristics as a part in consequence of the isolation; third, the presence or establishment in the isolated mass of an axial gradient or gradients; fourth, a new individuation and developmental history in consequence of the presence of the gradient and a dominant region. The axial gradients are not fundamental properties of protoplasm but result from local differences in the action of factors external to the protoplasm, cell, or cell mass in question. Orderly progressive development and definitely coordinated function are impossible except where such gradients exist or have existed.

Frank R. Lillie: *The Fertilizing Power of Sperm Dilutions.*

On the basis of the usual supposition that a single active spermatozoon may fertilize an egg of its own species, fertilization of eggs in series of sperm suspensions of increasing dilution should run in accord with the following law: To the point in the series in which each egg receives a single spermatozoon all of the eggs should be fertilized;

beyond this point the percentages of eggs fertilized should fall off at first slowly, then rapidly, and then slowly again to a vanishing point.

This condition is not realized, however, in actual experiments *unless* the time interval between preparation of the more dilute sperm suspensions and addition of the eggs is made very short (less than five minutes). Under such optimum conditions the curve of percentages of fertilized eggs begins to fall from 100 per cent. at a dilution of about 1/3000 of 1 per cent. sperm; the curve falls slowly to about 1/24000 per cent., then rapidly to about 1/300,000 per cent., then slowly again to about 1/90,000,000 per cent. where however about 1 per cent. of fertilizations may still take place. The observations show that beyond a dilution of 1/20,000 of 1 per cent. only a single spermatozoon can possibly be concerned in the fertilization of each egg.

If the time interval be lengthened to twenty minutes, fertilizing power of sperm suspensions may be completely lost at 1/1000 per cent., a point in the series of dilutions at which each egg recieves several spermatozoons. Comparing sperm suspensions of increasing dilution it is found that the rate of loss of fertilizing power is inversely proportional to concentration. Thus the time required for complete loss in a series of sperm suspensions between 1/600 per cent. and 1/120,000 per cent. forms a curve ranging from 45 down to 6 minutes. Presumably the time is even shorter at greater dilutions.

Spermatozoa may be perfectly motile after loss of fertilizing power. Their ineffectiveness in these experiments is therefore due to loss of a necessary substance. This is an interesting confirmation of the postulate, for which all experimental proof has hitherto been lacking, that the fertilizing power of spermatozoa is due to a definite substance. The spermatic substance in question represents the "sperm-receptors" of my theory of fertilization.

W. L. TOWER: *Experimental Production of a New Character.*

The antennæ of the Chrysomelidæ are highly invariable organs and are used but little in taxonomic differentiation, even of the genera and families. Of especial interest, therefore is the experimental production, by means of continued environmental pressure of a factorial group that is productive of antennal conditions not known to exist in any living or fossil Chrysomelidæ. In origin it arose progressively, in one direction, exists in three states of stability, each of which is capable of transference to other species through crossing, thus giving a picture of what may be one method of the production of nearly related genera. A final point of significance is that its behavior in crosses is no criterion of its method of origination, as it arose progressively, with all possible intergrades, but was at all points in the series alternative and dominant to the normal.

S. W. WILLISTON: *The American Land Vertebrate Fauna and its Relations.*

The land vertebrate fauna of Lower Permian or Permocarboniferous age in North America comprises, so far as now known, at least sixty definitely distinct genera, distributed about equally among the Amphibia, *Cotylosauria* and so-called *Pheromorpha.* From all other parts of the world, of approximately equivalent age, less than a dozen genera are known, for the most part imperfectly. In North America vertebrates are known only from New Mexico, Texas and Oklahoma, Illinois, and Pennsylvania. The fauna of New Mexico comprises, so far as is yet known, sixteen valid genera, twelve of them unknown elsewhere, the remaining four somewhat doubtfully identified with Texas forms. Not a single genus or family even of the American fauna is definitely known to occur elsewhere.

The American forms, and especially the higher reptiles, within the limits of their more generalized characters, are very diverse. That localities so little remote as Texas and New Mexico, though showing intimate family resemblances, should be so distinct in their genera is evidence that the world's fauna in Lower Permian times was an exceedingly abundant one. Probably at no time in the earth's history has there been a more extensive fauna of reptiles. As it is, there is no formation known in geological history of approximately equal duration that has yielded a greater number of genera of reptiles and amphibians than the American deposits.

The conclusion is legitimate that as early as the close of Carboniferous times the reptilian fauna of the world was a relatively old one. It has been urged that the relationships of this reptilian fauna with that of the Middle and Upper Permian of Africa was a close genetic one. From a recent study of most of the known specimens of European Permian vertebrates I am convinced that their resemblances are yet closer. On the other hand it has been urged that the American Permian fauna is an isolated one, with-

out any real genetic relationships with any known subsequent fauna; that such resemblances as have been shown are merely primitive or archaic, due to heredity from common ancestors. The truth probably lies between the two views.

VIII. *Physiology*

A. J. Carlson: *Some New Observations on the Physiology of the Stomach in Man.*

A. The relation of the stomach to the sensation of hunger. (1) Peripheral, and central control of the hunger mechanism. (2) Chemical control of the hunger mechanism. (3) The change in the hunger mechanism with age.

B. The relation of the stomach to appetite. (1) The qualitative difference between hunger and appetite.

C. The secretion of gastric juice in man. (1) The chemistry of normal human gastric juice. (2) Factors influencing the rate and quantity of the secretion. (3) The action of tonics or bitters on (*a*) the hunger mechanism; (*b*) on the secretion of gastric juice.

Shiro Tashiro: *On the Nature of Nerve Impulse.*

Lack of fatigue, as measured by ordinary methods, and absence of heat production during continued stimulation in the nerve, have driven some physiologists to consider that the nerve impulse passes through the fiber without consuming any material. With new apparatus which measures as little CO_2 as 0.0000001 gm., we have demonstrated that a living nerve gives off a definite amount of CO_2 and that when it is stimulated, this CO_2 production is increased. These new facts may be interpreted in two different ways. Some believe that a living nerve should be metabolically active like any other tissue, but that the chemical change is not identical with the nerve impulse, but is the result of functional activity. Others consider that the progress of chemical change itself constitutes the nerve impulse. This latter view is supported by some recent results, which show that CO_2 production from the resting nerve under different conditions is parallel to the physiological state of the nerve; that the normal nerve impulse passes toward a point of lower CO_2 production; that the rate of nerve impulse is closely connected with the rate of CO_2 production and that factors which influence the rate of nerve impulse equally influence the metabolism of the resting nerve. The nerve impulse is probably a propagated chemical change, the propagation being due to restoring the equilibrium which was disturbed first at the point of stimulus.

THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The sixty-sixth meeting of the American Association for the Advancement of Science and of the affiliated scientific societies will be held in Philadelphia beginning on December 28. We hope to publish next week full details of the preliminary program. It may now be noted that while the council of the association and some of its sections and affiliated societies will meet on Monday morning, the first general session will be held in the University gymnasium on Monday evening. The retiring president, Dr. Edmund B. Wilson, of Columbia University, will introduce the president of the meeting Dr. Charles W. Eliot, of Harvard University, and will give the annual address entitled "Some Aspects of Progress in Modern Zoology." After the meeting there will be a reception in the University Museum by Provost and Mrs. Smith.

The meetings of the sections and of most of the affiliated societies will be in the buildings of the laboratories of the University of Pennsylvania. Luncheon will be served daily in the gymnasium and all those in attendance are cordially invited to be present. The Houston Club is the headquarters at the University of Pennsylvania, and the Hotel Adelphia is the hotel headquarters.

An interesting event of the meeting will be the first session of the newly established section of agriculture, which will meet on December 30. The program will be a modest one, as becomes a new section, and will be specialized to cover some of the questions surrounding the business side of agriculture and the life of people living under it, rather than the strictly production phases. The address of the vice-president of the section, Dr. L. H. Bailey, late director of the College of Agriculture at Cornell University, will deal with "The Place of Research and of Publicity in the Forthcoming Country Life Development." The other main feature of the program will be a symposium on the general subject of "The Field of Rural Economics." Special phases of the subject will be presented by speakers invited to discuss

them, and there will be opportunity for somewhat general consideration. The importance of the economic aspects of agriculture and of rural affairs, and the broad field which the subject opens up, suggest this as an appropriate topic for the new section, and it is hoped that it will prove of general interest.

SCIENTIFIC NOTES AND NEWS

CHARLES SEDGWICK MINOT, James Stillman professor of comparative anatomy in the Harvard Medical School, eminent for his contributions to embryology and biology and for public service in science, died at his country home near Boston on November 19, at the age of sixty-two years.

THE gold medal of the Hayden Memorial Geological Award was presented to Dr. Henry Fairfield Osborn, in recognition of his paleontological studies, at a special meeting of the Academy of Natural Sciences of Philadelphia, on November 24. The presentation address was made by the president of the academy, Dr. Samuel G. Dixon.

ONE of the royal gold medals of the Royal Society, has been awarded to Professor Ernest William Brown, Sc.D., F.R.S., of Yale University, in recognition of his investigations in mathematical astronomy.

THE honorary degree of doctor of science was conferred on November 19 by Brown University upon Professor William H. Bragg, of the University of Leeds, before the corporation and faculty of the university in special convocation. Following the conferring of the degree Professor Bragg delivered the last of four lectures on "X-rays and Crystals," which he has been giving as the first of the anniversary lectures to celebrate the one hundred and fiftieth anniversary of Brown University.

THE John Fritz Medal will this year be awarded to Mr. John Edson Sweet, of Syracuse. Mr. Sweet was one of the founders of the American Society of Mechanical Engineers and one of its early presidents.

AT its last meeting the Rumford committee of the American Academy of Arts and Sciences made the following appropriations in aid of researches on light and heat: to Professor P. W. Bridgman, of Harvard University, $150 in addition to prior grants in aid of his researches on thermal effects at high pressures; to Professor Frederick A. Saunders, of Vassar College, $100 in aid of his research on the spectra of metallic vapors; to Professor Frederick Palmer, Jr., of Haverford College, in aid of his research on the properties of light of extremely short wave-lengths, $200; to Professor Henry Crew, of Northwestern University, in aid of his research on the specific heat of liquids, $200.

THE annual public address of the Philadelphia meeting of the Entomological Society of America will be given on Wednesday evening, December 30, in the rooms of the Academy of Natural Science, by Professor Stephen Alfred Forbes, of the University of Illinois and State Entomologist. His subject will be "The Ecological Foundations of Applied Entomology." At the same meeting Dr. Henry Skinner at the request of the executive committee of the society will present "A History of the Entomological Society of America."

THE anniversary meeting and reception of the New York Academy of Medicine took place on November 19. The anniversary discourse, entitled "Some of the Relations of the Profession of Medicine to Municipal Government" was delivered by the Hon. George McAneny, president of the board of aldermen of New York City.

M. BOUTROUX, professor in the University of Paris, has accepted an invitation of the British Academy to deliver the first of the recently endowed annual philosophical lectures. His subject will be "Certitude et Verité," and the lecture will probably be delivered early in December.

WORD has been received from Dr. W. C. Farabee, leader of the University of Pennsylvania's South American expedition, that he had just returned from a second successful trip up the Amazon. The party traveled some four thousand miles and returned with many valuable collections.

DR. JOHN L. HEFFRON, dean of the College of Medicine of Syracuse University, has been appointed a member of the advisory medical council of the state university for a term of five years.

KARL F. KELLERMAN has been recently promoted from the position of physiologist in charge of soil bacteriology investigations to be physiologist and assistant chief of the Bureau of Plant Industry, U. S. Department of Agriculture.

DR. F. B. POWERS is about to retire from the directorship of the Wellcome Chemical Research Laboratories, London, on December 1, in order to return to the United States. His period of service dates from the foundation of these laboratories by Mr. H. S. Wellcome in 1896. Dr. Power will be succeeded by Dr. F. L. Pyman. The character and policy of the Wellcome Chemical Research Laboratories will continue as in the past.

WE learn from *Nature* that by the will of W. Erasmus Darwin, eldest son of Charles Darwin, the Royal Society of London is bequeathed the sum of £1,650; his nephew, Mr. C. Galton Darwin, receives the portraits of Charles Darwin by Lawrence and Ouless, as well as Darwin's medals, Royal Society's candlesticks, snuff-box, christening mug, autobiography, notebook on children, two early sketches of "The Origin of Species," two volumes of "Hooker's Correspondence," the family Bible, the old Dutch brass-bound box containing the family papers, the letters written home from the *Beagle*, and pictures and miniatures. The desire is expressed that these relics should always be kept in the family.

PROFESSOR HERMAN J. KLEIN, director of the Astronomical and Meteorological Observatory of Cologne, editor of *Sirius*, has died at the age of seventy-two years.

MR. C. F. ADAMS, head of the department of physics of the Detroit Central High School, died on October 29, in his sixtieth year.

THE American Physical Society holds a meeting in Chicago on November 27 and 28.

THE fourteenth annual meeting of the American Philosophical Association will be held at Chicago, Ill., on December 28, 29 and 30, in acceptance of the invitation of the philosophical department of the University of Chicago. The Western Philosophical Association will meet in Chicago at the same time, and all sessions will be participated in by both associations. The Political Science Association also convenes at Chicago, and on December 29, in the afternoon, this association will join the two philosophical associations in a discussion of the subject of Democracy and Responsibility. In addition to this joint discussion there will be a discussion by the two philosophical associations of the subject selected by the executive committee of the American Philosophical Association as the main topic at this meeting. This subject is "The Interpretation of Justice, with Special Reference to Problems forced to the Front by Present Economic, Social and Political Conditions."

IT is announced that the award of the Nobel prizes for medicine, literature, chemistry and physics will be postponed till next year. It is proposed in future, as we have already noted, to make the formal distribution of the prizes every year in June instead of December 10, the anniversary of M. Nobel's death, when the awards will merely be announced.

APPLICATIONS for the Sarah Berliner fellowship for women of the value of one thousand dollars, available for study and research in physics, chemistry and biology, should be in the hands of the chairman of the committee, Mrs. Christine Ladd-Franklin, 527 Cathedral Parkway, New York, by January 1.

LAST summer the government of New Zealand took advantage of the meeting of the British Association for the Advancement of Science in Australia to invite a number of guests, including fifteen Americans and Canadians, whose names were given in SCIENCE at the time, to join in supplementary meetings in New Zealand. The plan was to hold a two-days' session in Wellington and in Christ Church. The war interfered with the carrying out of the program which had been planned by the New Zealand committee. When

the American visitors sailed from America on July 22, no intimation of the coming war had reached them. They arrived in New Zealand on August 13, in the early stages of the war, but the plans were not wholly abandoned. The committee in charge of the New Zealand meetings decided that they would like to have the American visitors lecture, each of them giving at least one lecture. Most of the American visitors have now returned to their homes.

News of the Routledge expedition to Easter Island is given in the *Geographical Journal.* Mr. Routledge writes little as to the scientific work so far accomplished, merely observing that the remarkable antiquities of the island were being examined by the party. He gives some account of disturbances in the island, due to unrest among the native Kanakas, about 250 in number. The main or only industry of the island—cattle rearing—is carried on by a company under the direction of an English manager, the only permanent white resident. Thefts of cattle and other property of the company had already been rife, when the natives put in a claim to the possession of all the cattle on the island—some 15,000 head—and began to destroy them wholesale. Such was the state of affairs, when the Chilean warship which visits the island every two or three years put in an opportune appearance, and for the moment relieved the situation. Four of the ringleaders were deported, but Mr. Routledge is inclined to anticipate further trouble. He describes the natives as unenterprising, and loath to work even for their own living.

THE United States Bureau of Mines has begun the collection of a general library of petroleum literature under the direction of W. A. Williams, chief petroleum technologist. The details of this work have been assigned to Dr. David T. Day, who has recently been transferred from the United States Geological Survey as petroleum technologist, and who will also assist in a thoroughly organized research into the chemistry of oils, which is being developed by the Bureau of Mines. It is hoped all technologists will aid in the work by exchanging with the bureau all available books and maps on this subject.

A MEETING was held on November 4, at the offices of the British Medical Association, to consider the position of the Belgian medical men and pharmacists, whose professional position has been involved in the utter ruin which has fallen upon their country and has destroyed the whole machinery of the medical profession and its adjuncts. The meeting was convened by the editors of the *Lancet* and the *British Medical Journal,* from which latter journal we take this reproduction, in response to representations made by a provisional Belgian committee, whose representative, Professor C. Jacobs, is now in London. Sir Rickman Godlee took the chair, and after a brief explanation of the position by Professor Jacobs, the following committee was appointed, with power to add to their number, to make an early report on the procedure to be adopted: Sir Thomas Barlow, president of the Royal College of Physicians of London; Sir Watson Cheyne, president, and Sir Frederic Eve, vice-president, of the Royal College of Surgeons of England; Dr. Meredith Townsend, master of the Apothecaries' Company; Sir Rickman Godlee; Dr. Frederick Taylor, president of the Royal Society of Medicine; Mr. T. Jenner Verrall, chairman of representative meetings of the British Medical Association; Dr. Des Vœux; Mr. E. T. Neathercoat, vice-president, and Mr. Woolcock, secretary, of the Pharmaceutical Society. Dr. Sprigge was appointed secretary and Dr. H. A. Des Vœux, treasurer. The instructions of the meeting to the committee were (1) to communicate with the Belgian Minister and the authorities of the Belgian Relief Fund; (2) to apply to America and other countries if desirable for assistance in the raising of any fund, and (3) to report generally.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board has granted $250,000 to Goucher College, Baltimore, conditionally upon $750,000 being raised by April 1, 1917.

A FUND of $60,000 has been turned over to Amherst College by the alumni council. The disposal of the income from this sum is to be

determined by action of the trustees and the council.

The corporation of Yale University has approved a plan for inviting full professors of the university to meet with the corporation at luncheon from time to time during the academic year.

Plans for the celebration next June of the semi-centennial anniversary of the founding of the Worcester Polytechnic Institute are rapidly taking definite shape. A program drawn up by a sub-committee consisting of Mr. Rockwood, Mr. Baker and Professor Coombs has been adopted, and the committee of three has been constituted an executive committee to carry it through. The exercises will begin on Sunday, June 6, and close on Thursday, June 10.

A certain number of Belgian professors and a growing number of students from Louvain, Liége, Ghent and Brussels are now in Cambridge, and although it has proved impossible for the Louvain University to transfer its corporate and official existence to Cambridge, unofficial courses have been instituted, combining, as far as possible, systematic instruction on the lines of the Belgian universities with the individual requirements of refugee students. It is typical of the disastrous conditions in Europe that in view of the appeal issued by the Belgian government for volunteers, it has been decided, in consultation with the Belgian government, that only such students as are physically unfit for military service or have been rejected for other reasons by the Belgian authorities, and are in possession of a certificate to that effect, can be accepted by the hospitality and academic committees.

R. T. Burdick has been promoted to an assistant professorship of agronomy at the University of Vermont and the State Agricultural College at Burlington.

In the chemistry department of Wesleyan Universtiy: Dr. M. L. Crossley, professor of organic chemistry at William Jewell College until 1913 and lecturer in Wesleyan University, 1913–14, has been appointed associate professor and acting head of the department. Dr. H. Lee Ward has been appointed associate professor in the department.

James Murray, B.S.A., manager of the farm of the Canadian Wheat Lands, Limited, at Suffield, Alberta, has been appointed to the chair of cereal husbandry in Macdonald College, McGill University, in succession to Professor L. S. Klinck, who resigned on August 1, to accept the deanship of the College of Agriculture of the University of British Columbia. Mr. Murray was formerly (1906–1911) superintendent of the Dominion Experimental Farm at Brandon, Manitoba.

DISCUSSION AND CORRESPONDENCE

CAHOKIA MOUND

In this journal, August 28, 1914, Mr. A. R. Crook presented a brief note on the origin of Cahokia Mound. The communication is here quoted in full:

> A study of the materials composing the so-called Monks or Cahokia Mound, in Madison County, Ill., establishes, beyond doubt, that it is not of artificial origin, as has been so generally held, but that it is a remnant remaining after the erosion of the alluvial deposits, which at one time filled the valley of the Mississippi, in the locality known as the "Great American Bottoms."

For the benefit of those who may not be familiar with the subject, and for this reason may be misled, we desire to say the statement made by Mr. Crook is erroneous and without the slightest degree of reason, and his conclusion would apply equally well to the pyramids of Gizeh or the ruins of the valley of Mexico.

Cahokia, by reason of its magnitude and importance, has led many to discuss its probable origin. Three theories have been advanced: (1) It is the belief of some that Cahokia is a natural formation. (2) Others regard the lower part natural and the upper part artificial. (3) Some, acknowledging it to be the work of man, believe it to have been erected at a period when the Mississippi flowed between it and the line of bluffs to the eastward, thus placing the mound on the right bank of the stream. However, no one of the

various hypotheses is compatible with existing facts and conditions, and there is no just or plausible reason why Cahokia should be considered other than the work of man, erected after the Mississippi had reached its present channel. True at some time in the past the waters of the Mississippi reached the foot of the bluffs now forming the eastern boundary of the wide lowland upon which the mounds stand. The waters gradually wore away the western bank of the stream until masses of limestone, now forming the cliffs on the Missouri side, were reached. Here a new and permanent channel was formed, and so it has remained until the present time. The entire area between the eastern line of bluffs and the limestone on the west was scoured by the advancing waters, and no single mass of the loose formation could have withstood the elements and thus remained an isolated mound near the center of the plain. The lowland was formed by the gradual shifting of the channel from the east to the west; this movement continued until it was arrested by the resistant limestone. Cahokia stands upon the lowland about midway between the two lines of bluffs. This area was reduced to its present level by erosion, during the time the stream was moving from the east and seeking its present bed. Therefore it would have been a physical impossibility for the mounds, standing at the present time, to have been erected at a time when the waters of the Mississippi flowed along the foot of the bluffs to the eastward.

Some five years ago Mr. N. M. Fenneman in "Physiography of the St. Louis Area," Bulletin 12, Illinois State Geological Survey, wrote (p. 63):

The partly artificial character of Monks' Mound is evident from its form. That it is in part a natural feature is seen by its structure. Sand is found neatly inter-stratified with loam at an altitude of about 455 feet, or 35 feet above its base. To this height, at least, the mound is natural and as there is sufficient other evidence that the valley was filled in the Wisconsin epoch to at least that height, the original mound may be regarded as a remnant of the alluvial formation of that time. Its base was probably narrowed artificially by the removal of material which was carried to the top. In this way also the conspicuous abruptness of its slopes was probably produced. No natural stratification has yet been found more than 35 feet above its base and therefore, for aught that is now known, more than half its height may be artificial.

The discovery of a mass of sand in the body of the mound does not prove the lower part of the structure to be of natural origin. The sand is mentioned as being "neatly inter-stratified with loam," but no statement appears as to the extent of the stratum. Was it found exposed on all sides of the work or only at one point? Probably the latter.

Of the great number of artificial mounds which have been examined few, if any, have been a homogeneous mass. Distinct strata of sand, clay, charcoal and ashes, vegetal mold or other materials, occur in the mounds. In some small deposits of clay, of sand and of black soil are in close contact, each mass being the quantity that could have been easily carried by one person. During the construction of the mounds many persons were necessarily engaged. The earth or sand was carried in bags or baskets from the chosen area and gradually the mass accumulated and the mound was formed. If a natural deposit of sand was encountered by the builders on one side of the work, while loam was being carried from another point, the result would be a pocket of sand in the artificial work. This may explain the occurrence of sand "neatly inter-stratified with loam," as mentioned by Mr. Fenneman. This question will be more clearly understood by referring to the writings of Mr. C. B. Moore, in which he describes the structure of many mounds excavated by him throughout the southern states, and likewise to the Twelfth Annual Report of the Bureau of Ethnology.

One illustration in Mr. Fenneman's work deserves mention, Fig. B, Pl. 6. This shows three mounds directly south of Cahokia and bears the legend:

Group of Mounds one half mile south of Monks' Mound. The low grassy knoll at the left is believed to be entirely natural. It suggests the original forms of the larger mounds which have been artificially shaped.

This conclusion proves the fallacy of Mr. Fenneman's argument, for although the two large mounds represented in the illustration have never been touched by the plow, the surface of the "low grassy knoll at the left" has been cultivated for many years, since early in the last century, and consequently its height has been reduced many feet. A sketch of the group made about the year 1840 and reproduced in "The Valley of the Mississippi," No. 3, September, 1841, shows the mounds to have been at that time of approximately the same height, therefore the "grassy knoll" was at one time thirty feet or more in height, and it is known that during the course of its destruction human remains were revealed by the plough.

Cahokia, the subject of this discussion, is the largest artificial earthwork in the United States. It stands in the extreme southern part of Madison County, Illinois, about six miles east of the Mississippi. It is in form a truncated rectangular pyramid, rising to a height of one hundred feet above the surrounding plain. Its base, rectangular in form, covers an area of about sixteen acres and measures 1,080 feet from north to south and 710 feet from east to west. Surrounding Cahokia are 69 lesser mounds, some of which are more than 40 feet in height. Some are circular, others rectangular; the latter, including Cahokia, are placed with their sides toward the cardinal points. A group of smaller mounds stood near the bank of the Mississippi a little south of west of the main group; between the two were several isolated mounds serving to connect the groups. On the opposite side of the river, on the summit of the ridge a short distance from the river, stood a group of 26 mounds, all of which have long since disappeared. These were within the limits of St. Louis.

As is generally known to those who are familiar with the distribution of mounds in the southern part of the country, there usually occurs in every group one mound which is larger and more imposing than the others. Often the larger work is separated from the main group by an open space, again it is more closely associated with the lesser mounds, sometimes being surrounded by them. The St. Louis group belonged to the former class; the larger group, with Cahokia near its center, belongs to the latter. The mounds of the St. Louis group, and those which formerly stood on the opposite side of the Mississippi, have disappeared, and many of the lesser works of the main Cahokia group have been practically obliterated by the plow. In view of these conditions it is gratifying to know that a movement is now being made to have Congress purchase, and set apart as a park, an area of sufficient size to include Cahokia and certain of the smaller mounds which have escaped destruction. This would preserve the largest earthwork in America, the most imposing aboriginal monument east of the Mississippi. It is quite evident that Mr. A. R. Crook, of Springfield, Ill., is antagonistic to this movement, but such statements as those recently made by him should not be allowed to influence the work now being done.

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AN EXAMINATION OF BLOOD-EJECTING HORNED LIZARDS

THE horned lizard's (or horned "toad's") remarkable habit of ejecting blood from its eye when attacked, although well authenticated, is so rarely observed that it is thought by many to have its origin and its creditability in the little animal's dragon-like appearance. Even Ditmars confesses that it took an actual demonstration, witnessed only after handling several hundred specimens, to upset his scepticism. His description of the performance is well known.[1]

Hay (1892), Stejneger (1893), Van Denburg (1897), Brunner (1907), Bryant (1911) and others have observed and mentioned this peculiar habit. It is not limited to any single species.

Various explanations have been suggested; among others that the phenomenon is connected with the breeding season, that it may be due to some parasite, and that it may be "a secondary use acquired by a relatively few forms."

[1] "The Reptile Book," p. 145.

Bryant sectioned the eyelids of a blood-ejecting specimen, and found them highly vascular and full of blood sinuses.

On July 4, while collecting specimens of *Phrynosoma cornutum* for examination of stomach contents, I was fortunate enough to witness this phenomenon. One of my students, walking by my side, stooped and thrust out his hand to pick up a large specimen, when he was met by a sudden spurt of blood coming unmistakably from the lizard's eye. The blood spread over the young man's hand in a fan shaped and even smear, extending from the second joint of the index finger to the wrist, and being about thirty mm. wide at the base. On July 7, another specimen, while being chloroformed, shot a quick jet of blood from one eye. The blood was given an almost explosive impulse, and formed a single thick drop on the inner wall of the bell jar. On July 20, another specimen ejected blood while being anesthetized. In this case, the blood on the wall of the bell jar was mixed with tiny fragments of skin and a few scales.

All three animals were subjected to a very careful examination. All were males. Their lengths were 108 mm., 110 mm. and 108 mm. The lizards were in good condition, even being free from tapeworms and other intestinal parasites with which local *Phrynosomas* are much infected. The stomach contents were characteristic, consisting of agricultural ants, small beetles, isopods, etc. In each case, the eye from which the blood was ejected showed a small quantity of clotted blood in the posterior corner. The vessels were slightly swollen. The cornea seemed to be intact. In the first two cases there was a small spot in the sclerotic coat, which can be best described as a blood blister. The contents on removal to a slide, and staining with Wright's stain, showed nothing except a few red corpuscles and lymphocytes. The third specimen showed nothing but a mass of clotted blood in the posterior corner of the eye. In each case, careful dissections were made, using needles and working under a 48 mm. objective. No parasites of any kind were found.

In my opinion, the most significant fact of all is that all three animals were moulting, the third being in quite an advanced stage.

W. M. Winton

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THE COTTON WORM MOTH AGAIN

The large northward flight of the cotton worm moth, *Alabama argillacea* Hubn., in September, 1911, is still fresh in the memory of entomologists. In 1912 a few of these moths were taken in Massachusetts, but in 1913 none were found, so far as the knowledge of the writer goes.

The present year none were reported in September, but on the evening of October 17, large numbers appeared at the lights in and around Worcester and were in evidence for several days. No other reports of their appearance in the state this year have been received, but it is hardly probable that they were only locally present.

It is interesting to note that while they were taken during the last week in September in 1911, and from September 21 to 25 in 1912, their first appearance this year was October 17, nearly a month later than in the other years mentioned.

Since the above was put in type this insect has also been reported as abundant in Pittsfield during the same period.

H. T. Fernald

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SCIENTIFIC BOOKS

Lehrbuch der Meteorologie. Von Dr. Julius Hann, Professor an der Universität Wien. Dritte, unter Mitwirkung von Professor Dr. Süring (Potsdam) umgearbeitete Auflage. Leipzig, 1913, 1914. Chr. Herm. Tauchnitz. 8vo. Pts. 1–9, pp. 800.[1]

It is significant of the progress of meteorology that three editions of von Hann's "Lehrbuch" have been published in the past twelve

[1] Ten parts are to be issued. The last one has been delayed, doubtless on account of the war.—*The reviewer.*

years. The first edition (1901) was at once accorded its rightful place at the head of the list of our meteorological text-books. No other book approached it as a complete, systematic, masterful discussion of the whole range of meteorological phenomena. The well-arranged and carefully selected bibliography alone was worth the cost of the entire volume. In 1906 came the second edition, in which the author introduced certain changes intended to make the "Lehrbuch" somewhat more popular, using that term in the best sense. The number of pages was reduced by 150; some of the less important details were omitted, and considerable reduction was made in the bibliographic notes. In this form the book, embodying all the noteworthy additions to meteorological knowledge which had been made during the years 1901–1906, became a most valued text and reference book to an increased number of readers.

To the great satisfaction of all workers in meteorological science, Professor von Hann has found opportunity, in the midst of his many other activities, and in spite of his advancing years, to revise his "Lehrbuch" once more, this time with the cooperation of Professor Süring. What we noted, in these columns, in regard to the first edition of this remarkable work is true, with added emphasis, of the latest issue. The general plan of the original edition has again been followed, in that the book has been increased in size, and the bibliographic notes, which were much reduced in the 1906 edition, have been restored, extended and brought down to date. For the purposes of the working meteorologist the new edition naturally has a greater value than the second, excellent as the latter was. No one can read over the new "Lehrbuch" without being profoundly impressed by the author's extraordinarily complete grasp of the whole range of meteorological literature. Everything is discussed in the light of the latest information which we have, and everywhere we see the touch of the master-hand, in the clean-cut, well-balanced and thoroughly digested discussions. Thorough as the treatment is, with marked emphasis upon the physical aspects of all the phenomena, the reader who is unfamiliar with mathematical analysis will not find the volume difficult to study. For, following the excellent plan already adopted in the first edition, the more technical mathematical and physical sections are included in an appendix. Special attention has been paid to the latest results of the aerological investigations which have become so important a branch of modern meteorology. The chapters on aerology, on clouds and on atmospheric electricity were prepared by Professor Süring, who is peculiarly competent to deal with these subjects.

Two of the matters concerning which meteorologists, as a whole, are still uncertain are the general circulation of the atmosphere and the theory of cyclones and anticyclones. Probably many readers of the "Lehrbuch" will turn at once to the discussion of these matters, in the hope that they may clear up their own minds on these debated topics. A reading of the sections in which these subjects are considered shows very clearly the gaps in our present knowledge of the facts, and the difficulty of giving satisfactory explanations under these circumstances. The case is stated clearly in the light of our present knowledge, but it is not a closed case.

Meteorologists will find, in the new edition of the "Lehrbuch der Meteorologie," their one absolutely indispensable reference book. Their colleagues, workers in other branches of science, will inevitably refer to this volume for the information which they may need to help them in their own investigations. Thus von Hann's "Lehrbuch" stands as the master-work on the science of the earth's atmosphere.

R. DeC. Ward

Harvard University

Die physikalische Chemie der Proteine. By Dr. T. Brailsford Robertson, professor of physiological chemistry and pharmacology in the University of California. Translated by F. A. Wyncken. Dresden, Verlag von Theodor Steinkopff. 1912. Pp. 447.

This book is a careful compilation of inves-

tigations relating to physical constants and properties of proteins. This line of study, as the author remarks, certainly deserves consideration on the part of chemists and biologists, although it is not yet satisfactorily developed. The book is divided into four parts: (1) chemical statics in protein systems (dealing with preparations of pure proteins and hypotheses concerning protein compounds); (2) electrochemistry of proteins (conductivity, etc); (3) physical properties of protein systems; (4) chemical dynamics in protein systems (hydrolysis of proteins, action of enzymes). Naturally the author's own investigations are discussed at length. In these he tries to apply those quantitative laws which, as a rule, are classified specifically as physicochemical: the gas laws, van't Hoff's theory of dilute solutions and all those other laws which can be derived from them on the basis of thermodynamics. The numerical data of the measurements fit the calculations well in most cases; the conclusion of the author, however, that protein solutions do not contain discrete particles does not seem perfectly justified, since investigations by Einstein and by Perrin have shown that even emulsions allow the application of the gas law in a certain form. Nevertheless the book will certainly prove extremely useful as a manual for all those who are interested in the further development of this important branch of science.

R. BEUTNER

Die Vorzeitlichen Säugetiere. By O. ABEL. Jena, Gustave Fischer, 1914. Pp. v + 309, with 250 figures and 2 tables in the text.

In the introduction the author emphasizes the dominance during the Mesozoic of the great reptiles—dinosaurs on land, mosasaurs in the sea, pterosaurs in the air—which, though mammals, had existed from the Upper Trias to the limit of the Cretaceous, put an effective check upon their evolutionary advancement. The principal abiding place of the mammals has always been the continents, yet by Middle Eocene time one finds the sea mammals, such as the whales and Sirenia, already evolved, and although the aerial realm has never been a domain of the mammals, the bats have for a long time competed with the birds, the heirs of the pterosaurs.

According to Steinmann, the different reptilian stems were not extinguished at the end of the Cretaceous period, but the great dinosaurs are said to have still existed in the great land mammals of the Tertiary, the ichthyosaurs in the dolphins, the mosasaurs in the baleen whales, the plesiosaurs in the sperm whales, the pterodactyls in the bats. This view Abel refutes upon anatomical and other grounds, and derives the mammals from a much more primitive reptilian stock. The author discusses the remarkable preservation of fossil mammals, as seen in the asphalt beds of the Rancho La Brea in California, frozen cadavers in the tundras of Siberia and those preserved in the oil-steeped soil of Galicia and the dry caverns of Patagonia, as well as in the ordinary mineralization of the bones. The principal localities which have produced mammalian remains are recorded; first those of the Mesozoic, then the European localities in their geologic sequence, followed by those of Asia, Africa, North America, South America and Australia in the order named. A very carefully wrought out chronological table is given, correlating the faunas of the five continental regions, the North American column presenting the six successive faunal phases as originally proposed by Osborn.

The oldest mammalian remains are discussed, no Permian ones being known, but the Upper Trias producing forms which seem to point to an origin at the latest by Permian time. The position of the ancient mammals in the "system" of living mammals is next dealt with historically. Abel recognizes the difficulty of erecting a system of classification which shall also give the phylogenetic stages in the history of any stock, and states that it almost seems as if it were impossible, on the basis of our present taxonomy, to form a satisfactory compromise between that and phylogeny. His own classification, though in many cases it does not give full recognition to phylogenetic facts, seeks, where possible, to lay emphasis on the historic and genetic

events in the history of the mammalian stocks.

The bulk of the book is taken up by a summary of the extinct mammals; first those without the placenta (Eplacentata), or the marsupials, including the Allotheria or multituberculates, the African *Tritylodon, Ptilodus* and *Polymastodon* of North America, and the various types described by Ameghino from Patagonia. After these comes a discussion of the diprotodont marsupials in Australia and South America, while the triconodonts are included with the polyprotodont types. Placental mammals embrace the Pantotheria or trituberculates and all forms above them, of which the insect-eating types or Insectivora are the most primitive; the author also includes under this head the unique Tillodonta, *Tillotherium* and its rare allies, whose position in the mammalian scheme is very doubtful. The relationships of the creodonts and fissipede Carnivora are clearly set forth, after which Abel describes the ancient whales.

The group of edentates are discussed under two distinct heads, the Xenarthra or "poor-toothed" mammals of South America, and the Nomarthra, those of the Old World, of which there are relatively very few. Rodents are briefly dismissed, the curious horned types, *Epigaulus* and *Ceratogaulus*, of the Miocene of Colorado and Kansas being emphasized as the most remarkable.

The hoofed mammals are always the most conspicuous and numerous forms in every fossil fauna, and to them the greater part of the volume under consideration is devoted. Twelve orders are recognized, of which the first is the "Stammordnung" Protungulata, embracing all of the forms usually included under the order Condylarthra and certain additional families such as the Pantolambdidæ, here considered as ancestral to the Amblypoda instead of being placed under that order as is the usual custom. The Bunolitopternidæ, ancestral to the Litopterna, are also placed here.

Following the ungulates, the primates are discussed, but a very brief section only is given to fossil man.

The final chapter of the book is upon the rise, dominance and decline of the mammalian stem. Of particular interest is the author's discussion of the causes of extinction, great emphasis being laid upon the possibility of contagious diseases having an extensive influence in the extinction of faunas.

Altogether the book is a well-balanced production which avoids excessive technicalities but gives a very good general idea of the more essential facts of mammalian anatomy, classification and relationships as disclosed by paleontology. It shows, moreover, how necessary for systematic work in recent zoology an adequate knowledge of extinct animals has become. An interesting commentary upon the advancement of paleontological science is afforded by the fact that the great bulk of illustrative material is drawn from American authorities and based upon the fossil resources of the New World.

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THE VEGETATION OF THE NEBRASKA SAND HILLS

THE average traveler regards the prairies and plains as regions of extreme monotony; particularly is this true if his way takes him through a region of sand hills. The total incorrectness of this view is admirably illustrated by the publication of Professor Pool's researches in the Nebraska sand hills.[1] From an earlier and semi-popular presentation by the same author we had learned to know something of the fascination and scientific interest of these dynamic landscapes, and now we have his detailed results.[2]

The Nebraska sand-hill country covers an area of about 18,000 square miles, that is, nearly a fourth of the area of the state. There are similar but smaller areas of sand hills in Kansas, Colorado and the Dakotas. The soil

[1] "A Study of the Vegetation of the Sandhills of Nebraska," Raymond J. Pool. *Minn. Bot. Stud.*, III., 4: 189–312, pls. 15, figs. 16, map 1, 1914.

[2] "Glimpses of the Great American Desert," Raymond J. Pool. *Pop. Sci. Mon.*, 80: 209–35, figs. 17, 1912.

is composed of dune sand, probably derived from the Loup Fork (Tertiary) beds. These hills seem to have been formed largely at some previous epoch and to have become stabilized and occupied by vegetation. Through the influence of man, mostly on account of prairie fires and overgrazing, many of these ancient dunes have become rejuvenated to the detriment of those responsible for it.

After giving the results of his careful measurements of wind, rainfall, evaporation, temperature and other ecological factors, Professor Pool takes up in detail the vegetation of the region. It is a pleasure to note the author's caution in using the word "formation." He rightly believes in using this term only for large units, referring the "formations" of many authors to associations. The characteristic upland formation is the prairie-grass formation, which is contrasted sharply with the short-grass formation of the plains, the two embracing most of the great climatic grasslands between our eastern forests and the mountains. These two great formations have similar physiognomy, but different component species; the limiting factors are the available water and competition, and not temperature, as supposed by Merriam. The chief association is the bunch-grass association, dominated especially by *Andropogon scoparius;* this is the vegetation that prevailed generally before the advent of the white man, and is regarded as the temporary climax of the region. The vegetation of this association is open, the grasses occurring in tufts or bunches, but it is supposed that ultimately some closed prairie-grass association will prevail. There is evidence of this in the spear grass association (dominated by *Stipa comata* and *Koeleria cristata*), and farther west in the grama-buffalo grass association (dominated by *Bouteloua* and *Bulbilis*).

Doubtless the most interesting features of the sand hills are the blow-outs. These are retrogressive features and are due, as noted above, especially to prairie fires and overgrazing. At first through the death of the plants there are small patches of bare sand. Later the sand is scooped out by the wind, forming conical or crateriform depressions, known as blow-outs. As the sand is scooped out, more sand falls in from the sides, so that the blow-out is increased in circumference, as well as in depth. Extreme cases are recorded where the depth may be as much as 100 feet and the circumference 600 feet. When wind erosion becomes checked, vegetation again gets a foothold, the chief pioneers being *Redfieldia flexuosa, Psoralea lanceolata* and *Calamovilfa longifolia.* After a time these pioneers are followed by the bunch-grass association; after this vegetational changes are much less rapid. One of the chief features of interest in the woodland formations along the streams is the overlap of the deciduous eastern forest and the yellow pine (*Pinus ponderosa scopulorum*) forest of the west. The lowland formations are much like those elsewhere, as to both content and succession, except that a meadow type represents the temporary climax; probably one of the more eastern of the prairie grass associations represents a more ultimate condition.

Professor Pool is to be congratulated on his thorough and sane treatment of his problem. His contribution is solid and satisfying, and is a pleasant contrast to the many ephemeral disquisitions which even yet masquerade too frequently under the name of ecology.

H. C. COWLES

SPECIAL ARTICLES

THE EFFECTS OF SMALL REPEATED INTRAPERITONEAL INJECTIONS OF WITTE'S PEPTONE SOLUTIONS IN GUINEA-PIGS[1]

THE experiments reported in this preliminary paper form a group in a series which has been planned to determine the organic effects of parenteral introduction of certain substances which may be produced within the tissues of an organism, or which may be absorbed from the gastro-intestinal tract. The fact that Longcope[2] has reported that parenteral diges-

[1] From the laboratories of the Cincinnati General Hospital and the department of pathology of the University of Cincinnati.

[2] Longcope, *Jour. Exp. Med.*, 1913 (18), 678.

tion of egg-albumen may (under certain circumstances) produce organic renal and hepatic changes may mean that splitting of the whole protein leads to these changes, that the effects are the results of the irritant action of substances set free during splitting, or that moieties of the protein molecule by making abnormal combinations may act as irritants, or in some other undetermined way embarrass the activities of the cells of the tissues in which they occur.

In two former publications, Newburgh and I[3] reported the results of a series of injections of indol and tyrosin in animals, and stated that we were able to discover little if any change in any of the parenchymatous organs. In the present series use has been made of solutions of albumose as represented by Witte's peptone.

The protocols follow: In them the expression "peptone solutions" means one prepared as follows and then sterilized:

Witte's peptone	1 gram.
Sodium chloride	0.5 "
Distilled water	100.0 c.c.

Guinea-pig 1.—Weight 400 grams. This animal received 17 daily injections each of 1.5 c.c. of the peptone solution, a total of 25.5 c.c., or .255 gram of albumose. It died suddenly on the day following the last injection. The cause of death was not discovered. The post-mortem was done while the animal was still warm, and showed no other changes than a slight mediastinal edema, moderate hyperplasia of the lymph-nodes and congestion of the lungs, liver, spleen and kidneys. Microscopic examination (Lab. No. 1078) of the tissues showed edema and congestion with occasional small hemorrhages in the kidneys, with a few areas of small round cell infiltration; enormous congestion of the adrenals; edema and focal necroses of the thymus; and hyperplastic changes associated with congestion in the lymph glands and spleen. The spleen was more than normally pigmented.

[3] Woolley and Newburgh, *J. A. M. A.*, 1911 (56), 1796; and Newburgh and Woolley, *Cin. Lancet-Clinic*, April 13, 1912.

Guinea-pig 2.—Weight about 350 grams. This animal received 57 daily injections each of 1.5 c.c. of the peptone solution; a total of 85.5 c.c., or .855 gram of albumose. During the period of treatment it gave no sign of any untoward effects of the treatment. It ate well, lost no weight, and was finally chloroformed 72 hours after the last injection. The post-mortem was done while the body was still warm. The organs showed no abnormal macroscopic or microscopic (Lab. No. 1205) lesions, other than a moderate, generalized congestion associated with a very moderate edema of the parenchymatous organs. This, however, was no more than is usual after chloroform anesthesia.

Guinea-pig 3.—Weight about 400 grams. This animal received 30 daily intraperitoneal injections each of 1.5 c.c. of the peptone solution, a total of 5 c.c. or .45 gram of albumose. It was killed with chloroform. The post-mortem showed only a very moderate congestion and edema of the liver, spleen, kidneys and adrenals, and a slight hyperplasia of the mesenteric lymph glands. Microscopic examination (Lab. No. 1179) showed nothing abnormal except perhaps a slight degree of hyperplasia of the mesenteric lymph glands.

Guinea-pig 4.—Weight about 400 grams. This animal received 5 c.c. of the peptone solution each day for 7 days, 35 c.c., or .35 gram of albumose. It was killed with chloroform. At autopsy nothing was found which was abnormal. Microscopic examination (Lab. No. 1243) was equally negative.

Guinea-pig 5.—Weight about 350 grams. This animal was treated in the same manner as No. 4 for a period of 20 days, during which time it received a total of 100 c.c. of the peptone solution, or 1 gram of albumose. It was chloroformed and autopsied. During the period of treatment it lost 87 grams in weight. At autopsy nothing noticeable was found except a partially healed meager exudate on the surface of the spleen. The peritoneal cavity contained 2 c.c. of a clear fluid. Microscopic examination of the tissues (Lab. No. 1276) showed no lesions except in the case of the spleen, in which there was an increased amount

of pigment and a moderate hypertrophy of the Malpighian follicles. The capsule was thickened.

Guinea-pig 12.—Weight 412 grams. This animal received 50 intraperitoneal injections of 5 c.c. of the peptone solution in the course of two months, a total of 250 c.c., or 2.5 grams of albumose. After each injection it was submitted to deep chloro-anesthesia for 15 minutes. After 25 treatments the weight had increased to 455 grams. At the end of the treatments the weight was 485 grams. The post-mortem revealed nothing macroscopically abnormal, and physically the animal seemed to be in the best sort of condition. Histological examination (Lab. No. 1595) showed that there was a certain amount of anatomic modification of the tissues of some of the organs. The report was as follows: The kidney shows a well-marked edema and cloudy swelling. The glomerular spaces are dilated and the tufts compressed, and in the spaces there is considerable coagulated albuminous material. About the glomeruli there are frequent small accumulations of small round cells, and in the outer layers of the cortex there are occasional lines of interstitial fibrosis. The whole organ showed congestion. The liver showed a very well developed edema, to the extent that in many areas the cells show what seems to be hydropic changes. With this is associated congestion and very moderate interstitial fibrosis as exemplified in the occasional collections of small round cells in the perilobular connective tissues. The spleen shows enormous hyperplasia of the Malpighian follicles together with some increased pigmentation. Within the corpuscles there is evidence of cellular fragmentation. The adrenals show a few collections of formative cells in both medulla and cortex, chiefly in the latter. The other organs revealed nothing remarkable.

Guinea-pig 11.—Weight 445 grams. This animal was treated in exactly the same way as No. 12. After 25 treatments it weighed 482 grams and at the end of the experiment, 565 grams. The report of the histologic examination (No. 1609) stated that the changes were similar to those found in No. 12, except that there were a few retention cysts in the kidneys and that there was nothing of note in the adrenals except an intense congestion.[4]

In this series, which is admittedly small, there is evidence (which we are attempting to verify by an extended series of experiments) that albumose introduced parenterally into the guinea-pig has very little, if any, harmful effect unless the oxidative powers of the organism are below normal. In view of the results of Longcope's experiments, as compared with ours, it seems possible that the more complex proteins will produce effects in the absence of decreased oxidation which the less complex ones will not produce under similar circumstances.[5] We are carrying out a series of experiments which we hope will throw some light upon this problem.

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DAISY CLARK,
AMIE DEMAR

THE CULTURE OF DIDYMIUM XANTHOPUS (DITMAR) FR.

IN a recent attempt to isolate an ascomycetous fungus occurring abundantly on the seed pods of sweet clover (*Melilotus*) there appeared on one of the plates an organism that had spread over the surface of the synthetic medium. The striking feature was the network of anastomosing branches varying in width and height to about two millimeters. These were brownish yellow, and slightly raised above the surface of the agar, the whole having the appearance of the vascular system of some maple leaves, as seen on the ventral surface. Microscopical examination showed that these ridges were composed of granular protoplasm with no evidence of a containing vessel or cell wall. About ten days after discovery the culture was again examined and

4 The histologic examinations in these cases were made by Dr. T. H. Kelly, who had no knowledge of the experimental procedures used in the individual cases. They were subsequently verified by one of us (P. G. W.).

5 These results call to mind Opie's work along somewhat similar lines (*Trans. Assoc. Amer. Phys.*, 1910, XXV., 140).

showed at that time areas of fully developed sporangia which indicated that this organism was a Myxomycete. A culture was submitted to Dr. Thomas H. Macbride, who identified the organism as *Didymium xanthopus* (Ditmar) Fr.

Since the first appearance of this organism cultures have been readily established by transferring small portions of the vegetative form to fresh media, and also by sowing spores. At the present time the third generation from spores is growing luxuriantly and is furnishing excellent material for further study of this very interesting organism. It has been possible to obtain practically all stages in the formation of the sporangium by fixing material taken every two hours during the process of development.

It can also be readily observed with the low power microscope that the protoplasm exhibits reversible streaming movements in somewhat definite channels. This movement occupies but a few seconds in each direction, first accelerating and then retarding to a point of rest before reversing. This feature will have some value to the teacher who wishes to demonstrate protoplasmic streaming to students, for it is superior to any other material observed for this purpose.

A more extensive report of morphological and physiological studies of this organism will be published at a later date.

John P. Helyar

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THE EFFECT ON PLANT GROWTH OF SATURATING A SOIL WITH CARBON DIOXIDE

The following note reports a greenhouse experiment with corn and tomato plants where the soil surrounding the roots was gradually saturated with carbon dioxide, the aerial portions of the plants being under normal conditions throughout the experiment. The plants were grown in six-inch earthenware pots in a normal greenhouse soil. Both kinds of plants grew uniformly and there was no choice between the individual corn or tomato plants selected for the experiment.

A bell-jar, about ten liters in capacity and of the same shape as an ordinary aspirator bottle, was placed over one of the tomato plants. The earthenware pot containing the plant was raised up so that as much as possible of the plant was outside the jar. Absorbent cotton was placed about the plant at the mouth of the bell-jar. The bell-jar was put on a glass plate smeared with vaseline. One of the corn plants was treated in exactly the same way. No carbon dioxide was added for a week and the plants growing in the pots, enclosed by the bell-jars, made as good growth as the check plants.

A steady stream of washed carbon dioxide, of such speed that it gave two bubbles of gas per second as it passed through the wash bottle, was led into each of the bell-jars through a side opening near the bottom of the jar. This was continued for two weeks.

The lower parts of the plants were affected first and in a week the ill effects extended entirely over the plants. The leaves drooped, turned brownish, withered and curled up. The veins of both treated plants darkened. The plants were practically brown at the end of two weeks' treatment, the tomato plant being more physiologically affected than the corn plant.

After two weeks the side openings through which the carbon dioxide had been introduced were left open. The tomato plant soon damped off at the mouth of the bell-jar, while the corn plant began to revive, sent out new growth and at the end of a week was growing normally. Two weeks after the treatment was discontinued it had made ten inches of new growth.

From the way the check plants grew, the greenhouse temperature was satisfactory for plant growth and the soil was a normal one. The bell-jars did not produce the results, as they did not inhibit growth before the carbon dioxide was applied or after its application was discontinued. A carbon dioxide saturated soil upset the growth of these plants but did not change the soil so that the plant could not grow after its application was discontinued.

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THE EFFICIENCY OF HALOGENS IN INDUCING METAMORPHOSIS IN FROG LARVÆ[1]

GUDERNATSCH has shown in his interesting and important experiments on the effect of feeding larval frogs upon the substance of certain glands with internal secretions, that thyroid accelerates metamorphosis to a marked degree. Inasmuch as the present writer has been studying the involution of the organs of the tadpole during metamorphosis, Gudernatsch's results were of significance and opened at once the question as to what component of the thyroid exerted this accelerating effect. To the solution of this problem I turned my attention during the past summer, hoping that data would be found to aid in interpreting the observations which have already been made upon the physiological processes involved during metamorphosis.

Attention was first directed to the thyroid constituents. All of the iodin-bearing portions of the gland substance gave positive results, while the nucleoprotein, lipoid and other fractions were negative. The negative results given by feeding lipoid is significant in the light of the theory of von Fürth that cholin is responsible for the vaso-motor effects of thyroid; for the lipoid-free thyroid substance gave positive results, showing that cholin, which is present in thyroid only in the lecithins, is not functional in a vaso-motor capacity in inducing the different changes in the metamorphosing tadpole. Other evidence, such as ligation of the chief blood-vessels of the tail previous to and during involution, which does not affect the rate of tissue absorption, points to the fact that blood changes are not responsible for metamorphosis.

Iodin seems to be associated in the thyroid with a globulin which Oswald has called thyreoglobulin, which, on hydrolysis, is reducible to a mass called iodothyrin by Baumann; this is a mixture of end-products of protein disintegration and especially of amino-acids, some of which, such as tryptophan and tyrosin, probably hold the iodin in some sort of association, but in what way is not known at present. Now in the present set of experiments, thyreoglobulin, iodothyrin and an iodated amino-acid, tyrosin (3, 5, diodo-tyrosin), gave positive results when fed separately to the larvæ. The tyrosin used was from a pancreatic digest and after recrystallization it was iodated at 0° C. with resublimed iodin scales.

Other iodin compounds, not derived from the thyroid, were examined. Starch iodate, marine iodin-bearing algæ, iodated hen's egg lecithin and all of the inorganic iodides tried gave negative results. Iodated Witte Peptone gave positive results, quite comparable in every way with those obtained with thyroid. Inasmuch as only "organic" iodin gave positive results and then only when associated with proteins, the conclusion seems to be warranted that the iodin, in order to be available, must be in some way associated with amino-acids. The iodin of the plant material is known not to be in the same form as in thyroid, for in algæ it is always associated with potassium, probably as KI; therefore the plant iodin is not an exception.

Two theories may be proposed to account for this effect of iodin: (1) If the process of involution is due to phagocytosis as Metchnikoff, Mercier and many others believe, we have a basis for the accelerating action of iodin in the work of Marbé, who has shown that organic iodin preparations raise the opsonic index of blood of mammals. (2) If, as the work of Loss and of the present writer[2] up until the present time seems to show, the process concerns, initially, at least, some factor other than phagocytosis, and that probably it is a matter of autolysis, then we may resort to the results obtained by Kepinow, where iodin accelerates that process. In all probability, the rôle of iodin is two-fold, that is, instigating and accelerating autolysis in the first place, and secondly, favoring phagocytosis. While we do not know certainly what relation exists between the destructive changes, collectively designated involutionary and those concerned with differentiation, results obtained by the

[1] The complete details of this work are published in another journal (*Jour. Biol. Chem.*, Vol. 19, 110–13).

[2] *Proc. Soc. Exp. Biol. and Med.*, Vol. 11, p. 184; *idem.*, Vol. 10, p. 31; *Amer. Jour. Physiol.*, December, 1914.

writer point to the invariable precedence of the former, so that these may set up processes of differentiation.

M. MORSE

MADISON, WIS.,
September 25, 1914

SOCIETIES AND ACADEMIES

BOTANICAL SOCIETY OF WASHINGTON

THE ninety-eighth regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club at 8 P.M., October 6, 1914. Forty members and two guests were present. The following scientific program was given:

Mr. P. H. Dorsett, "The Botanical Garden of Rio de Janeiro, Brazil" (with lantern).

Mr. W. F. Wight, "Andean Origin of the Cultivated Potato" (with lantern and specimens).

Both papers are to be published elsewhere.

The fourteenth annual meeting of the Botanical Society of Washington was held at 1:30 P.M., October 23, 1914, with twenty-nine members present. The customary reports were presented and approved and the following officers were elected for the ensuing year: Dr. R. H. True, president; Mr. G. N. Collins, vice-president; Professor C. E. Chambliss, recording secretary; Dr. Perley Spaulding, corresponding secretary; Mr. H. C. Gore, treasurer, and Mr. W. E. Safford, vice-president to the Washington Academy of Sciences.

The ninety-ninth regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club at 8 P.M., November 3, 1914. Forty-nine members and three guests were present. Mr. Wilson Popenoe was unanimously elected to membership. The scientific program was:

Mr. Paul Popenoe, "The Date Palm in Antiquity" (with lantern).

The speaker referred particularly to the influence of the date palm on the religion of the Semitic peoples. Prized for the food and drink it furnished, it was revered because of the mystery of sex emphasized by its monœciousness, and became identified with the primitive mother goddess of fertility. A sacred palm in a garden at Eridu, near the mouth of the Euphrates River, is thought by many investigators to be the origin of the Tree of Life of the Garden of Eden, described in Genesis. The culture of the palm was thoroughly known at a very early period, the Babylonian inscriptions giving reason to believe that it was more skilful 1900 years B.C. than it is in that region 1900 years A.D.

Mr. W. E. Safford, "The Economic Plants of Ancient Peru."

This paper was based upon collections and observations made by the writer while cruising along the Peruvian and Chilian coast, in 1887, and while acting as commissioner for the World's Columbian Exposition to Peru and Bolivia, in 1891 to 1893. Prehistoric graves were opened at Caldera, Iquique, Arica, the Rimac Valley, Ancon, Chimbote, Truxillo, and the vicinity of Payta. The material obtained is mainly in the Field Columbian Museum at Chicago and the United States National Museum. In addition to objects of ethnological interest many articles were found illustrating the ethnobotany of Ancient Peru. Not only were seeds, seed-pods, dried fruits, leaves and tubers found, but beautiful representations of many of the food plants in terra-cotta, in the form of funeral vases, were discovered in graves near the coast, especially at Chimbote and Truxillo. Among these were a number not included in Wittmack's list published in Reis & Stuebel's great work "Das Todtenfeld von Ancon." Beautiful models in terra-cotta of the tubers of *Solanum tuberosum* were found, also of the fruits of *Solanum muricatum* and *Lucuma obovata*, and most interesting of all the almond-like kernels of *Caryocar amygdaliforme* R. & P., easily distinguished by their protruding recurved embryo. Another interesting object was a terra-cotta vase representing the roots of the achira (*Canna edulis*). The collections include specimens of *Phaseolus vulgaris* and *Phaseolus lunatus*, a gourd full of peanuts (*Arachis hypogæa*) and models of the same on terra-cotta vases; mandioca roots and models of the latter; quantities of maize and models of the same on funeral vases; bags of coca leaves (*Erythroxylum Coca*), and specimens of raw cotton, dark brown, light brown and white, together with spindles with cotton yarn upon them; looms with half-woven fabrics and textiles of beautiful and intricate designs. Among the most interesting of the funeral vases were forms representing the corn god of ancient Peru, a monster with protruding tusks, surrounded by ears of maize; and the god of agriculture, represented with a stalk of maize in one hand and a stalk of mandioca in the other, with a cluster of roots at the base very much like those of a dahlia.

The paper was illustrated by numerous slides, principally of objects in the collection of the Field Columbian Museum.

PERLEY SPAULDING,
Corresponding Secretary

ˇ# SCIENCE

FRIDAY, DECEMBER 4, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

X-RAYS AND CRYSTALLINE STRUCTURE[1]

Two years have gone by since Dr. Laue made his surprising discovery of the interference effects accompanying the passage of X-rays through crystals. The pioneer experiment has opened the way for many others, and a very large amount of work, theoretical and practical, has now been done. As the preliminary exploration of the new country has proceeded, our first estimate of its resources has grown continuously; we have learned many things which help us to a better understanding of phenomena already familiar, and we have seen avenues of enquiry open out before us which as yet there has been little time to follow. The work is full of opportunities for exact quantitative measurements, where precision is sure to bring its due reward. There is enough work in sight to absorb the energies of many experimenters, and there is sure to be far more than we can see. When we consider the wideness of the new field, the quality and quantity of the work to be done in it, and the importance of the issues, we are scarcely guilty of over-statement if we say that Laue's experiment has led to the development of a new science.

The experiment itself—to put it very briefly—constitutes a proof that X-rays consist of extremely short ether waves. In order to appreciate the value of this demonstration, we must bear in mind the present conditions of our knowledge of the laws of radiation in general. Let us consider very shortly how the whole matter stood when the new work was begun.

When X-rays were first discovered eighteen years ago it was soon pointed out that they might consist of electro-magnetic disturbance of the ether analogous to those supposed to

[1] Read before the weekly evening meeting of the Royal Institution of Great Britain, June 5, 1914.

constitute light. It was true that the new rays seemed to be incapable of reflection, refraction, diffraction and interference, which were familiar optical phenomena. But it was pointed out by Schuster[2] that these defects could be explained as natural consequences of an extremely small wave-length. The positive evidence consisted mainly in the knowledge that the impact of the electrons on the anti-cathode of the X-ray bulb ought to be the occasion of electro-magnetic waves of some sort, and in the discovery by Barkla that the X-rays could be polarized, which last is a property also of light.

As experimental evidence accumulated, a number of results were found which the electromagnetic theory was unable to explain, at least in a direct and simple manner. They were mainly concerned with the transference of energy from place to place. In some way or other the swiftly moving electron of the X-ray bulb transfers its energy to the X-ray, and the X-ray in its turn communicates approximately the same quantity of energy to the electron which originates from matter lying in the track of the X-ray, and which is apparently the direct cause of all X-ray effects. Experiment seemed to indicate that X-ray energy traveled as a stream of separate entities or quanta, the energy of the quantum differing according to the quality of the X-ray. It looked at one time as if it might be the simplest plan to deny the identity in nature of X-rays and light, to describe the former as a corpuscular radiation and the latter as a wave motion. Otherwise, it seemed that the electromagnetic hypothesis would be torn to pieces in the effort to hold all the facts together.

But it appeared on a close examination of light phenomena also, though in much less obvious fashion, that the very same effects occurred which in the case of X-rays were so difficult to explain from an orthodox point of view. In the end it became less difficult to deny the completeness of the orthodox theory than the identity in nature of light and X-rays. Modern work on the distribution of energy in the spectrum, and the dependence of specific heat upon temperature, has also led independently to the same point of view. It has been urged with great force by Planck, Einstein and others that radiated energy is actually transferred in definite units or quanta, and not continuously; as if we had to conceive of atoms of energy as well as of atoms of matter. Let it be admitted at once that the quantum theory and the orthodox theory appear to stand in irreconcilable opposition. Each by itself correlates great series of facts; but they do not correlate the same series. In some way or other the greater theory must be found, of which each is a partial expression.

The new discovery does not solve our difficulty at once, but it does two very important things. In the first place, it shows that the X-rays and light are identical in nature; in fact, it removes every difference except in respect to wave-length. The question as to the exact place where the difficulty lies is decided for us; we are set the task of discovering how a continuous wave motion, in a continuous medium, can be reconciled with discontinuous transferences of radiation energy. Some solution there must be to this problem. The second important thing is that the new methods will surely help us on the way to find that solution. We can now examine the X-rays as critically as we have been able to study light, by means of the spectrometer. The wave-length of the X-ray has emerged as a measurable quantity. The complete range of electromagnetic radiations now lies before us. At one end are the long waves of wireless telegraphy, in the middle are first the waves of the infra-red detected by their heating effects, then the light waves, and then the short waves of the ultra-violet. At the other end are the extremely short waves that belong to X-radiation. In the comparative study of the properties of radiation over this very wide range we must surely find the answer to the greatest question of modern physics.

So much for the general question. Let us now consider the procedure of the new investigations, and afterwards one or two applications to special lines of enquiry.

The experiment due to Laue and his collab-

[2] *Nature*, January 23, 1896.

orators Friedrich and Knipping has already been described in this lecture room and is now well-known. A fine pencil of X-rays passes through a thin crystal slip and impresses itself on a photographic plate. Round the central spot are found a large number of other spots, arranged in a symmetrical fashion, their arrangement clearly depending on the crystal structure. Laue had anticipated some such effect as the result of diffraction by the atoms of the crystal. His mathematical analysis is too complicated to be described now, and indeed it is not in any circumstances easy to handle. It will be better to pass on at once to a very simple method of apprehending the effect which was put forward soon after the publication of Laue's first results. I must run the risk of seeming to be partial if I point out the importance of this advance, which was made by my son W. Lawrence Bragg. All the recent investigations of X-ray spectra and the examination of crystal structure and of molecular motions which have been carried out since then have been rendered possible by the easy grasp of the subject which resulted from the simpler conception.

Let us imagine that a succession of waves constituting X-radiation falls upon a plane containing atoms, and that each atom is the cause of a secondary wavelet. In a well known manner, the secondary wavelets link themselves together and form a reflected wave. Just so a sound wave may be reflected by a row of palings, and very short sound waves by the fibers of a sheet of muslin.

Suppose a second plane of atoms to lie behind the first and to be parallel to it. The primary wave weakened somewhat by passing through the first plane, is again partially reflected by the second. When the two reflected pencils join it will be of great importance whether they fit crest to crest and hollow to hollow, or whether they tend to destroy each other's effect. If more reflecting planes are supposed, the importance of a good fit becomes greater and greater. If the number is very large, then, as happens in many parallel cases in optics, the reflected waves practically annul each other unless the fit is perfect.

It is easily seen that the question of fit depends on how much distance a wave reflected at one plane loses in comparison with the wave which was reflected at the preceding plane: the fit will be perfect if the loss amounts to one, two, three, or more wave-lengths exactly. In its turn the distance lost depends on the spacing of the planes, that is to say, the distance from plane to plane, on the wave-length and on the angle at which the rays meet the set of planes.

The question is formally not a new one. Many years ago Lord Rayleigh discussed it in this room, illustrating his point by aid of a set of muslin sheets stretched on parallel frames. The short sound waves of a high pitched bird call were reflected from the set of frames and affected a sensitive flame; and he showed how the spacing of the planes must be carefully adjusted to the proper value in relation to the length of wave and the angle of incidence. Rayleigh used the illustration to explain the beautiful colors of chlorate of potash crystals. He ascribed them to the reflection of light by a series of parallel and regularly spaced twinning planes within the crystal, the distance between successive planes bearing roughly the same proportion to the length of the reflected wave of light as the distance between the muslin sheets to the length of the wave of sound.

Our present phenomenon is exactly the same thing on a minute scale: thousands of times smaller than in the case of light, and many millions of times smaller than in the case of sound.

By the kindness of Professor R. W. Wood I am able to show you some fine examples of the chlorate of potash crystals. If white light is allowed to fall upon one of them, the whole of it is not reflected. Only that part is reflected which has a definite wave-length or something very near to it, and the reflected ray is therefore highly colored. The wave-length is defined by the relation already referred to. If the angle of incidence is altered, the wave-length which can be reflected is altered, and so the color changes.

It is not difficult to see the analogy between

these cases and the reflection of X-rays by a crystal. Suppose for example that a pencil of homogeneous X-rays meets the cube face of such a crystal as rocksalt. The atoms of the crystal can be taken to be arranged in planes parallel to that face, and regularly spaced. If the rays meet the face at the proper angle, and only at the proper angle, there is a reflected pencil. It is to be remembered that the reflection is caused by the joint action of a series of planes, which, in this case, are parallel to the face; it is not a reflection by the face itself. The face need not even be cut truly: it may be unpolished or deliberately roughened. The reflection takes place in the body of the crystal, and the condition of the surface is of little account.

The allotment of the atoms to a series of planes parallel to the surface is not of course the only one possible. For example in the case of a cubic crystal, parallel planes containing all the atoms of the crystal may also be drawn perpendicular to a face diagonal of the cube, or to a cube diagonal, or in many other ways. We may cut the crystal so as to show a face parallel to any series, and then place the crystal so that reflection occurs, but the angle of incidence will be different in each case since the spacings are different. It is not necessary to cut the crystal except for convenience. If wave-length, spacing and angle between ray and plane are rightly adjusted to each other, reflection will take place in the crystal independently of any surface arrangement.

This is the "reflection" method of explaining the Laue photograph. W. L. Bragg showed in the first place that it was legitimate, and in the second that it was able to explain in the position of all the spots which Laue found upon his photographs. The different spots are reflections in different series of planes which may be drawn to contain the atoms of the crystal. The simpler conception led at once to a simpler procedure. It led to the construction of the X-ray spectrometer, which resembles an ordinary spectrometer in general form, except that the grating or prism is replaced by a crystal and the telescope by an ionization chamber and an electroscope. In use a fine pencil of X-rays is directed upon the crystal, which is steadily turned until a reflection leaps out; and the angle of reflection is then measured. If we use different crystals or different faces of the same crystal, but keep the rays the same, we can compare the geometrical spacings of the various sets of planes. If we use the same crystal always, but vary the source of X-rays, we can analyze the latter, measuring the relative wave-lengths of the various constituents of the radiation.

We have thus acquired a double power: (1) We can compare the intervals of spacing of the atoms of a crystal or of different crystals, along various directions within the crystal; in this way we can arrive at the structure of the crystal. (2) We can analyze the radiation of an X-ray bulb; in fact we are in the same position as we should have been in respect to light if our only means of analyzing light had been by the use of colored glasses, and we had then been presented with a spectrometer, or some other means of measuring wave-length exactly.

We now come to a critical point. If we knew the exact spacings of the planes of some one crystal, we could now by comparison find the spacings of all other crystals, and measure the wave-length of all X-radiations; or if we knew the exact value of some one wave-length, we could find by comparison the values of all other wave-lengths, and determine the spacings of all crystals. But as yet we have no absolute value either of wave-length or of spacings.

The difficulty appears to have been overcome by W. L. Bragg's comparison of the reflecting effect in the case of rocksalt or sodium chloride, and sylvine or potassium chloride. These two crystals are known to be "isomorphous"; they must possess similar arrangements of atoms. Yet they display a striking difference both in the Laue photograph and on the spectrometer. The reflections from the various series of planes of the latter crystal show spacings consonant with an arrangement in the simplest cubical array, of which the smallest element is a cube at each corner of which is placed the same group, a single

atom or molecule, or group of atoms or molecules. In the case of rocksalt, the indications are that the crystal possesses a structure intermediate between the very simple arrangement just described and one in which the smallest element is a cube having a similar group of atoms or molecules at every corner and at the middle point of each face. The arrangement is called by crystallographers the face centered cube. The substitution of the sodium for the potassium atom must transform one arrangement into the other. This can be done in the following way, if we accept various indications that atoms of equal weight are to be treated as equivalent. Imagine an elementary cube of the crystal pattern to have an atom of chlorine at every corner and in the middle of each face, and an atom of sodium or potassium as the case may be, at the middle point of each edge and at the center of the cube. We have now an arrangement which fits the facts exactly. The weights of the potassium and chlorine atoms are so nearly the same as to be practically equivalent, and when they are considered to be so, the arrangement becomes the simple cube of sylvine. But when the lighter sodium replaces the potassium as in rocksalt the arrangement is on its way to be that of the face centered cube, and would actually become so were the weight of the sodium atoms negligible in comparison with those of chlorine. Of course the same result would follow were two or three, or any number of atoms of each sort to take the place of the single atom, provided the same increase were made in the number of the atoms of both sorts. We might even imagine two sorts of groups of chlorine and metal atoms, one containing a preponderance of the former, the other of the latter, but so that two groups, one of each kind, contain between them the same proportion of chlorine and metal as the crystal does. We must merely have two groups which differ in weight in the case of rocksalt, and are approximately equal in weight in the case of sylvine. But it was best to take the simplest supposition at the outset; and now the evidence that the right arrangement has been chosen is growing as fresh crystals are measured. For it turns out that in all crystals so far investigated, the number of atoms at each point must always be the same. Why, then, should it be more than one? Or in other words, if atoms are always found in groups of a certain number, ought not that group to be called the atom?

As soon as the structure of a crystal has been found we can at once find by simple arithmetic the scale on which it is built. For we know from other sources the weight of individual atoms, and we know the total weight of the atoms in a cubic centimeter of the crystal. In this way we find that the nearest distance between two atoms in rocksalt is 2.81×10^{-8} cm., which distance is also the spacing of the planes parallel to a cube face. From a knowledge of this quantity the length of any X-ray wave can be calculated at once as soon as the angle of its reflection by the cube face has been measured. In other words, the spectrometer has now become a means of measuring the length of waves of any X-radiation, and the actual spacings of the atoms of any crystal.

From this point the work branches out in several directions. It will not be possible to give more than one or two illustrations of the progress along each branch.

Let us first take up the most interesting and important question of the "characteristic" X-rays. It is known that every substance when bombarded by electrons of sufficiently high velocity emits X-rays of a quality characteristic of the substance. The interest of this comparison lies in the fact that it displays the most fundamental properties of the atom. The rays which each atom emits are characteristic of its very innermost structure. The physical conditions of the atoms of a substance and their chemical associations are largely matters of the exterior: but the X-rays come from the interior of the atoms and give us information of an intimate kind. What we find is marked by all the simplicity we should expect to be associated with something so fundamental.

All the substances of atomic weight between about 30 and 120 give two strongly defined "lines"; that is to say, there are found among

the general heterogeneous radiation two intense almost homogeneous sets of waves. For instance, rhodium gives two pencils of wave-lengths, approximately equal to 0.61×10^{-8} cm. and 0.54×10^{-8} cm. respectively. More exactly the former of these is a close doublet having wave-lengths 0.619×10^{-8} and 0.614×10^{-8}. The wave-lengths of palladium are nearly 0.58×10^{-8} and 0.51×10^{-8}; nickel 1.66×10^{-8} and 1.50×10^{-8}. Lately Moseley has made a comparative study of the spectra of the great majority of the known elements, and has shown that the two-line spectrum is characteristic of all the substances whose atomic weights range from that of aluminium, 27, to that of silver, 108. These X-rays constitute, there is no doubt whatever, the characteristic rays which Barkla long ago showed to be emitted by this series of substances.

Now comes a very interesting point. When Moseley sets the increasing atomic weights against the corresponding decreasing wave-lengths, the changes do not run exactly parallel with each other. But if the wave-lengths are compared with a series of natural numbers everything runs smoothly. In fact it is obvious that the steady decrease in the wave-length as we pass from atom to atom of the series in the periodic table implies that some fundamental element of atomic structure is altering by equal steps. There is excellent reason to believe that the change consists in successive additions of the unit electric charge to the nucleus of the atom. We are led to think of the magnitude of the nucleus of any element as being simply proportional to the number indicating the place of the element in the periodic table, hydrogen having a nuclear change of one unit, helium two, and so on. The atomic weights of the successive elements do not increase in an orderly way; they mount by steps of about two, but not very regularly, and sometimes they seem absolutely to get into the wrong order. For example, nickel has an atomic weight of 58.7, whereas certain chemical properties and still more its behavior in experiments on radio-activity indicate that it should lie between cobalt (59) and copper (63.6). But the wave-lengths, which are now our means of comparison, diminish with absolute steadiness in the order cobalt, nickel, copper. Plainly, the atomic number is a more fundamental index of quality than the atomic weight.

It is very interesting to find, in the series arranged in this way, four, and only four, gaps which remain to be filled by elements yet undiscovered.

Let us now glance at another and most important side of the recent work, the determination of crystalline structure. We have already referred to the case of the rocksalt series, but we may look at it a little more closely in order to show the procedure of crystal analysis.

The reflection of a pencil of homogeneous rays by a set of crystalline planes occurs, as already said, at a series of angles regularly increasing; giving as we say, spectra of the first, second, third orders, and so on. When the planes are all exactly alike and equally spaced the intensities of the spectra decrease rapidly as we proceed to higher orders, according to a law not yet fully explained. This is, for example, the case with the three most important sets of planes of sylvine, those perpendicular to the cube edge, the face diagonal, and the cube diagonal respectively. An examination of the arrangement of the atoms in the simple cubical array of sylvine shows that for all these sets the planes are evenly spaced and similar to each other. It is to be remembered that the potassium atom and the chlorine atom are so nearly equal in weight that they may be considered effectively equal. In the case of rocksalt the same may be said of the first two sets of planes, but not of the third. The planes perpendicular to the cube diagonal are all equally spaced, but they are not all of equal effect. They contain alternately, chlorine atoms (atomic weight 35.5) only and sodium atoms (atomic weight 23) only. The effect of this irregularity on the intensities of the spectra of different orders is to enhance the second, fourth, and so on in comparison with the first, third and fifth. The analogous effect in the case of light is given by a grating in which the lines are alternately light and

heavy. A grating specially ruled for us at the National Physical Laboratory shows this effect very well. This difference between rocksalt and sylvine and its explanation in this way constituted an important link in W. Lawrence Bragg's argument as to their structure.

When, therefore, we are observing the reflections in the different faces of a crystal in order to obtain data for the determination of its structure, we have more than the values of the angles of reflection to help us; we have also variations of the relative intensities of the spectra. In the case just described we have an example of the effect produced by want of similarity between the planes, which are, however, uniformly spaced.

In the diamond, on the other hand, we have an example of an effect due to a peculiar arrangement of planes which are otherwise similar. The diamond crystallizes in the form of a tetrahedron. When any of the four faces of such a figure is used to reflect X-rays, it is found that the second order spectrum is missing. The analogous optical effect can be obtained by ruling a grating so that, as compared with a regular grating of the usual kind, the first and second, fifth and sixth, ninth and tenth alone are drawn. To put it another way, two are drawn, two left out, two drawn, two left out, and so on. The National Physical Laboratory has ruled a special grating of this kind also for us, and the effect is obvious. The corresponding inference in the case of the diamond is that the planes parallel to any tetrahedral face are spaced in the same way as the lines of the grating. Every plane is three times as far from its neighbor on one side as from its neighbor on the other. There is only one way to arrange the carbon atoms of the crystal so that this may be true. Every atom is at the center of a regular tetrahedron composed of its four nearest neighbors, an arrangement best realized by the aid of a model. It is a beautifully simple and uniform arrangement, and it is no matter of surprise that the symmetry of the diamond is of so high an order. Perhaps we may see also, in the perfect symmetry and consequent effectiveness of the forces which bind each atom to its place, an explanation of the hardness of the crystal.

Here, then, we have an example of the way in which peculiarities of spacing can be detected. There are other crystals in which want of uniformity both in the spacings and in the effective value of the planes combine to give cases still more complicated. Of these are iron pyrites, calcite, quartz and many others. It would take too long to explain in detail the method by which the structures of a large number of crystals have already been determined. Yet the work done already is only a fragment of the whole, and it will take no doubt many years, even though our methods improve as we go on, before the structures of the most complicated crystals are satisfactorily determined.

On this side then we see the beginning of a new crystallography which, though it draws freely on the knowledge of the old, yet builds on a firmer foundation since it concerns itself with the actual arrangement of the atoms rather than the outward form of the crystal itself. We can compare with the internal arrangements we have now discovered the external forms which crystals assume in growth, and the modes in which they tend to come apart under the action of solvents and other agents. By showing how atoms arrange and disarrange themselves under innumerable variations of circumstances we must gain knowledge of the nature and play of the forces that bind the atoms together.

There is yet a third direction in which enquiry may be made, though as yet we are only at the beginning of it. In the section just considered we have thought of the atoms as at rest. But they are actually in motion, and the position of an atom to which we have referred so frequently must be an average position about which it is in constant movement. Since the atoms are never exactly in their places, the precision of the joint action on which the reflection effect depends suffers materially. The effect is greater the higher the order of the spectrum. When the crystal under examination is contained within a suitable electric furnace and the atoms vibrate more violently

through the rise of temperature, the intensities of all orders diminish, but those of higher order much more than those of lower. The effect was foreseen by the Dutch physicist Debije, and the amount of it was actually calculated by him on certain assumptions. I have found experimental results in general accord with his formula. In passing it may be mentioned that as the crystal expands with rise of temperature the spacing between the planes increases and the angles of reflection diminish, an effect readily observed in practise.

This part of the work gives information respecting the movements of the atoms from their places, the preceding respecting their average positions. It is sure, like the other, to be of much assistance in the enquiry as to atomic and molecular forces, and as to the degree to which thermal energy is locked up in the atomic motions.

This brief sketch of the progress of the new science in certain directions is all that is possible in the short time of a single lecture: but it may serve to give some idea of its fascination and possibilities.

WILLIAM H. BRAGG

WALTER HOLBROOK GASKELL (1847–1914)

DR. WALTER HOLBROOK GASKELL, university lecturer on physiology and prælector on natural science at the University of Cambridge since 1883, died suddenly, after a short illness, on September 7, 1914. He came of a well-known Unitarian family in the north of England, and was born at Naples, on November 1, 1847. After receiving his preliminary education, he entered Trinity College, Cambridge, in 1865, subsequently taking a medical degree at University College, London, in 1878. At Cambridge, Gaskell was one of the earliest to come under the influence of Michael Foster, then prælector on physiology, and, at his instance, entered Ludwig's laboratory at Leipzig in 1874. Prior to Foster's advent, Gaskell had specialized in mathematics, being one of the wranglers in the Mathematical Tripos in 1869. From the date of his first paper, an important research on the vaso-dilator fibers of striated muscle,[1] the rest of his life was devoted to those researches on the motor mechanism of the heart and the sympathetic system which have made his name so well known in physiology and clinical medicine.

English physiology in the first half of the nineteenth century was represented mainly by the work of Sir Charles Bell (spinal nerve roots), Marshall Hall (reflex action), William Sharpey (ciliary motion), Sir William Bowman (theory of urinary secretion), William Prout (HCl in the gastric juice) and Thomas Graham (osmosis, colloids). In 1867 Michael Foster was Sharpey's assistant at University College, and, in 1870, at Huxley's instance, became prælector at Cambridge, while Burdon Sanderson became Waynefleet professor of physiology at Oxford in 1882. From the teaching and inspiration of these two men came most of the brilliant names which have distinguished English physiology in the later period, with the exception of Starling, whose name is associated with Guy's Hospital. Schaefer was a Sharpey pupil, and was persuaded by Foster to devote his life to research. Leonard Hill and Gotch were Oxford men. From Cambridge came Langley, Henry Head, Sherrington, Roy, Adami, Gowland Hopkins and Gaskell.

When Gaskell began to work with Ludwig, every one believed in the so-called neurogenic theory of the heart's action, introduced by Borelli in 1680, viz., that the heart's movements, beat and tonus are due to nervous impulses. A little before Borelli, Harvey, in his demonstration of the circulation of the blood (1628), had advanced the idea that the heart is a muscular force pump, propelled by its own internal heat. This mystic dogma (the myogenic theory) was stated in more modern form by Haller in 1757, viz., that the heart's contraction is due to an inherent "irritability" of its muscle, the stimulus being the entrance and passage of venous blood through it. Both theories, neurogenic and myogenic, have had their ups and their downs to date. The neurogenic theory was restated by Legallois in

[1] *Proc. Roy. Soc. Lond.*, 1877, XXV., 43[illegible]-445.

1812, and seemingly confirmed by the Webers' discovery that stimulation of the vagus nerve will stop the heart (1845); and by the discovery of intrinsic nerve ganglia in the heart by Remak (1848) and Bidder (1852), which were thought to be involved in the celebrated experiment of Stannius (1852), viz., that a ligature or cut between the sinus venosus and the auricles produces standstill, while a second ligature applied to the auriculo-ventricular groove causes the ventricle to beat again. The modern revival of the myogenic theory is the work of Engelmann and Gaskell.

Between 1874 and 1881, Gaskell made a long series of ingenious investigations upon the musculature and innervation of the heart, the results of which, as given in his great memoir of 1881[2] and later, may be summarized, however inadequately, as follows:

1. The motor impulses from the nerve ganglia in the sinus venosus are discrete, not continuous, stimuli, influencing the rhythm of the heart (its rate and force) but not originating either its movements or its beat.

2. Cardiac muscle can contract of itself and is a stimulus-producer. The five properties of cardiac (or other) muscle, as deduced by Gaskell, are excitability, conductivity, tonicity, rhythmicity and automatic contractile power. This power of automatic, rhythmic contractility has been recently confirmed in Burrows's extra-vital cultures of embryonic heart muscle,[3] which contain no nervous tissue whatever.

3. That the automatic contraction wave proceeds from sinus venosus to ventricle without nervous intervention is proved by Gaskell's and Engelmann's sections in the cardiac muscle, excluding the nervous tissues, and leaving only a narrow isthmus for the transmission of the rhythmic impulse. Gaskell reversed this peristaltic wave by stimulating the ventricle after the second Stannius ligature, showing that the normal impulse could not have started from the cardiac ganglia.

4. Gaskell first produced experimental "heart-block" (a term of his invention) by clamping the auriculo-ventricular and sino-auricular grooves, which he calls "the two natural blocking points" of the muscular contraction wave. In his view, the original Stannius experiments become simple cases of temporary block. This view has been brilliantly confirmed by the discovery of the vestigial muscular structures known as the auriculo-ventricular bundle of His and the sino-auricular node of Keith and Flack; also by the clinical and pathological findings in the disease described by Morgagni in 1761 and now known as heart-block or the Stokes-Adams syndrome. Gaskell even produced the two-, three- and four-time gallops of modern clinicians, in which the ventricle drops one or more of its beats. Schiff's observation that the ventricle of a dying heart beats slower than the auricle is interpreted as the effect of a gradually increasing block. Gaskell also produced the clinical condition known as "fibrillation of the heart" in an isolated strip of cardiac muscle, interpreting the phenomenon as due to blocking of the connections between individual muscle cells. In recent medicine, the various rhythmic disorders of the heart are regarded, not as cases of nervous imbalance, but as the effects of blocking of the peristaltic wave which passes from sinus venosus to bulbus arteriosus, and from muscle fiber to muscle fiber.

5. Schmiedeberg's observation that stimulation of the vagus after administration of nicotine will accelerate the heart led Gaskell to a series of investigations in comparative histology. He found that the hearts of warm-blooded and cold-blooded animals have the same innervation, that the inhibitory fibers of the vagus are medullated, the accelerator fibers non-medullated, leading to the important conclusion that both sets of fibers belong, not to the cerebro-spinal system, but to "the great system of efferent ganglionated nerves" (autonomic system), the function of which is the redistribution of impulses along collateral paths by means of fibers passing to and from an especial sympathetic ganglion or synapse. The efferent nerve cells of the inhibitory system lie in the heart itself, those of the accelerator system lie in external sympathetic ganglia, the nerve cells in either case being a switch (Foster's synapse) for the transmission of impulses. In 1890, Langley showed that nicotine will paralyze the medullated or pre-ganglionic fiber of a sympathetic ganglion without affecting the non-medullated (post-ganglionic) fiber. Schmiedeberg's experiment was, therefore, only a special case of Langley's nicotine effect. He was really stimulating the preganglionic or inhibitory fibers of the vagus; the switchboard effect across the synapse was abolished, the accelerator fibers from the external ganglia being unaffected by the poison.

2 *Phil. Tr.*, Lond., 1883, CLXXIII., 993–1033.

3 SCIENCE, 1912, XXXVI., 90–92.

6. The vagus, therefore, acts both as whip and bridle, spur and snaffle to the heart. The intrinsic ganglia being only bridges for the transmission of impulse, the true function of the vagus, in Gaskell's view, is not inhibitory but *quiescent*, acting upon the heart muscle itself. Gaskell revives Borelli's hypothesis[4] that the effect is chemical. The vagus is defined as the anabolic nerve of the heart. Inhibition is anabolism.[5] The vagus is a trophic nerve, both for muscle and ganglia.

7. Galvanometer observations showed that stimulation of the accelerator and inhibitor fibers produced opposite electrical effects which were independent of contraction, since they could be observed in a quiescent heart. These electromotive effects were first mapped and measured by A. D. Waller in 1889. Einthoven's string galvanometer made it possible for the physician to obtain "electrocardiograms" or telegrams from the heart, giving its electromotive condition, a field of investigation which Gaskell was the first to enter.

8. Gaskell regards certain discrepancies in the findings of experimentation upon the heart as due to chemical and nutritive changes in different hearts at different times of the year.

These results, the most important work on the heart since Ludwig, are embodied partly in Gaskell's Croonian Lecture of 1881, and, in more mature and complete form, in his splendid monograph in Schaefer's "Physiology" (1898). His comparative researches on the innervation of different animals lead him to his next great work, the mapping out and interpretation of the nerve supply of the entire vascular and visceral systems, culminating in his exhaustive memoir of 1886.[6] In this, it was shown, by microscopical observation, that the supply of nerves from the spinal cord to the chain of sympathetic ganglia originates mainly from the thoracic and upper lumbar regions, in which white rami, made up of medullated nerves, form the connection. Although it is now known that the cerebro-spinal system alone governs reflex actions, it was formerly supposed that the sympathetic system was also concerned in the change of afferent impulses to efferent. The mapping out of the sympathetic nerves in their distribution from the spinal roots between the second thoracic and second lumbar vertebræ and the inclusion of the nerves proceeding from the cranial and sacral nerve roots, as a part of a greater system, distributed to the viscera, blood vessels, ductless glands and all organs or regions supplied by smooth (involuntary) muscle, was the special work done by Gaskell. This system was defined and interpreted by Langley as the "autonomic" system, the function of the sympathetic and cranio-sacral autonomics being the redistribution of impulses along all efferent paths which do not terminate in voluntary muscle, these paths proceeding from a neuron in the spinal cord to an external sympathetic ganglion or synapse, from whence the post-ganglionic fibers pass to the glands or muscles. The study of these paths began with Gaskell's investigations on the accelerator nerves of the heart. Langley's nicotine method proved the means of isolating individual synapses, as the drug acts selectively on the autonomic ganglia and not on the cerebro-spinal. In internal medicine, the connection of the autonomic systems with the ductless glands forms part of the interesting theory of the correlation of the internal secretions advanced by the Viennese clinicians, Eppinger, Falta and Rüdinger.

The remaining years of Gaskell's life were taken up with his theory, formulated in 1889, that the central canal of the nervous system was originally the lumen of a primitive gut, which is elucidated at length in his book on "The Origin of Vertebrates" (1908). In 1893, in connection with his work on the Hyderabad Chloroform Commission, Gaskell,

[4] Borelli believed that a contracting muscle actually increases in bulk through a fermentation started in its substance from a hypothetic "*succus*" discharged from the nerve.

[5] This view is opposed by Langley, and it does not harmonize with the experiments on isolated hearts in Ringer's solution by Howell and others. The limiting semi-permeable envelope of a living cell, organ or body is usually regarded as the agent of anabolism, preventing the undue dissipation of energy.

[6] "On the Structure, Distribution and Function of the Nerves which Innervate the Visceral and Vascular Systems," *Jour. Physiol.*, Lond., 1886, VII., 1–80.

with Dr. L. E. Shore, made an interesting contribution to pharmacology,[7] showing that chloroform lowers blood pressure by acting directly upon the heart, and not on the vasomotor center, as had hitherto been supposed.

Gaskell was an unassuming, sympathetic character, and it is said that every physiologist who has worked in the Cambridge Laboratory since its start was his personal friend. His eminent colleague, Professor J. N. Langley, thus describes him:

> Gaskell cared little for public ceremonies, and rarely attended the congresses which beset the path of prominent scientific men. He loved to work quietly, to cultivate his garden, to see his friends, and to take a hand at whist or bridge. His house at Great Shelford was a recognized meeting-place for physiologists, and his frank and genial welcome will be an abiding recollection to all who knew him.

F. H. GARRISON
ARMY MEDICAL MUSEUM

DR. GASKELL'S WORK ON ORGANIC EVOLUTION

It is not with any idea of writing an appreciation either of the man or of his work as a whole that I venture to present this sketch. His work within the limits of the narrower field of physiology—the observations on the effect of a rise in tension of the muscles upon the caliber of the lymphatic vessels, the long series of experiments upon the relation of the vagus and accelerator nerves to the heart and on cardiac muscle, the work on the nerves to the salivary gland—has been dwelt upon by others.[1] I wish rather to call attention to some of the unusual features, and their bearing on the wider biological problems of the day.

Gaskell's work on the origin of vertebrates was begun under conditions that most investigators would consider unfavorable. His wife became afflicted with an obscure nervous disorder, not diagnosed at that rather early date, and his presence was required more and more at his home. Not wishing to give up investigation during his enforced absence from the laboratory, and having his attention turned toward the central nervous system, he began to enquire into its origin and development in the various animal phyla. Regarding the nervous system as the fixed and permanent structure in phylogenetic development, he concluded that the alimentary tract might be the thing to be made over in the transition from the invertebrate with ventral nerve cord to vertebrate with its dorsal nerve cord, and drew up his scheme of the origin of the vertebrates on this basis. Although Gaskell has brought together a vast amount of evidence bearing on this point,[2] his theory has been treated with scant courtesy by most morphologists. It is a common occurrence to hear it glibly and vigorously condemned by people who have never read his book or weighed independently for themselves the evidence adduced in support of the theory. It is worthy of remark in this connection that Gaskell was a pioneer worker in a line which has led in very recent years to the development of a large and important field in the morphology of the central nervous system—the field now included in the component theory of nerves. And he has shown in a way which has had its influence upon other theories of the origin of vertebrates, that the older idea of the formation of a new nervous system while the alimentary tract remained intact in phylogeny is not an assumption to be made lightly. But whether the theory of the origin of vertebrates as he propounded it be right or wrong, a matter which I venture to regard as still unsettled, certain of Gaskell's conceptions of the nature of fundamental biological processes are firmly and surely grounded. It is of these that I wish more particularly to speak.

Gaskell recognized very clearly the importance of the rôle played by internal processes in evolution. In 1910, he wrote:

> Now the formation of the Metazoa from the Protozoa and the progress of the Metazoa upwards signifies that the separate units composing

[7] Lancet, Lond., 1893, I., 386.

[1] Langley, *Nature*, 1914, Vol. 94, No. 2343, p. 93. *British Medical Journal*, 1914, No. 2804, p. 559.

[2] Gaskell, "The Origin of Vertebrates," New York and London, 1908.

the individual have been coordinated for the well-being of that individual. Such coordination has taken place in two ways: (1) a chemical method, by the formation of hormones; (2) a nervous method, by the formation of a central nervous system, and it is self-evident that as soon as a central nervous system is formed, such nervous coordination, especially in connection with the formation of the special senses of sight and smell, must become the important factor in the life of the individual, and its further and further development must constitute the most important factor for the upward progress of the animal race.[3]

The fundamental importance of this idea is likely to be lost for the general reader in the almost platitudinous simplicity of the statement. In reality, there is much matter for long and profound reflection. The idea of chemical coordination, although of comparatively recent development, has claimed the attention of a host of workers, partly perhaps because of its novelty, and the nervous mechanism has, by contrast, become a neglected field. But in the development of the purely chemical mechanisms of coordination, so far as they have been traced at present, we find that they reach their maximum efficiency and complexity well down in the mammalian phylum. It is probable that, so far as the purely chemical mechanisms are concerned, man is not a more complex animal than the rabbit, and certainly not a more complex animal than the dog. Yet the total difference between man and the rabbit or the dog is considerable. The reason for this difference is not far to seek. It lies in the difference of the nervous systems of the two forms, and in the interaction of this system with the chemical mechanisms of coordination. After the chemical mechanisms have reached their zenith, the nervous system still shows, step by step, an increasing complexity, functionally as well as structurally, as successively higher types of animals are examined.

I walked out to Dr. Gaskell's house from Cambridge early one August afternoon two years ago, intending to make a brief call, but the afternoon was far gone and the sun low in the west before I started for the little railroad station at Great Shelford. The conversation turned on the rôle of the internal factors in evolution. He remarked:

> It is not size, it is not strength, that has conferred the great advantage in the struggle, but acuteness.

The hand and arm of man are often cited as adaptations of a high degree of perfection conferring a great advantage upon its possessor. This is but a part of the story. The hand and arm without a nervous system to control or coordinate its movements would be valueless. The hand and arm of a recent hemiplegic may have lost little or nothing in bone or muscle, but, despite its complex structure, it is of less use to its possessor than the foreleg and hoof of a horse. The clot of blood in the cerebrum has wrecked the mechanism which also is necessary if the marvelous hand of man is to be of use to him in the struggle for existence. Nor would the combination of the man's hand and the dog's brain be a more happy one. The feeble-minded and the idiotic often show but slight and unimportant physical modifications aside from those found in the brain. When looked at from the point of view of its functional relations to the whole organism, or from the point of view of its use to the possessor, neither hand nor motor nervous system alone is significant, but it is the combination of the two—the coordination—that is the important thing. And in addition to the mere manual skill arising from the steady nerves and the strong hand, the faculty of looking into the future—the acuteness and accuracy of mental vision—constitutes a valuable adjunct to the possessor of an organism whose chemical mechanisms of coordination give rise to no physical discomforts. The nervous mechanisms of coordination, as well as the chemical, will surely claim the serious attention of the student of evolution from its functional side. And it is not single structures or organs alone which become significant in evolution, but the coordination of all parts of an organism.

[3] *Proceedings of the Linnean Society of London*, Session 122, 1909–10, p. 9.

One corollary may be drawn from this main proposition. From the point of view of its function, neither the hand as a whole nor any of its parts which become of any real significance can be regarded as a unit character. In the inception of the character there must have been some changes in the nutrition of the tissues—some change in the chemical mechanism of coordination—rendering such a departure possible, and such a change in a chemical system seldom arises without some associated change in conditions, near or remote. And when the character has developed to a stage at which it becomes significant, it acquires this significance only because it may enter into correlated or coordinated activity with other parts of the organism through the medium of chemical or nervous mechanisms, or both. It is difficult for a physiologist to regard any one portion of the body as an isolated mechanism acting without reference to any other mechanism. The tendency to regard a mechanism as an isolated mechanism has often led into error. And the attempts by experimental methods completely to isolate any mechanism so that it acts independently of every other has proved to be a difficult and for the most part impossible process under present laboratory conditions. In the living animal under its various conditions of existence, coordination is an indispensable process. And since the processes of evolution are concerned with living animals rather than dead ones, the mechanisms of coordination become the important factors in evolution. For it is these internal factors which modify in greater degree than any others the growth and development of the organism in any environment in which life is possible.

That Gaskell clearly recognized the importance of coordination and insisted upon it is clear from the extract quoted above. To recognize clearly amid the multiplicity of confusing detail the fundamental factors in organic evolution regarded from its functional side, is a noteworthy achievement. And to state the problem in terms of biological phenomena rather than in metaphysical terms is to give to other biologists a fruitful working hypothesis. It is with a poignant sense of a personal as well as a scientific loss that many of us have read the recent announcement of his death. A kindly, sturdy, clear-eyed Briton, England need have little fear for the future of its science if she can produce more of his like.

F. H. PIKE

DEPARTMENT OF PHYSIOLOGY,
COLUMBIA UNIVERSITY

THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND AFFILIATED SOCIETIES

THE preliminary announcement for the meetings of the American Association and those of the Affiliated Societies which will meet with it at Philadephia during the coming convocation week has now been sent to members. The arrangements for the meeting are well under way and a strong local committee has been appointed, of which Provost Edgar F. Smith is chairman, Dr. J. H. Pennimann is vice-chairman, Dr. Philip P. Calvert is secretary, and Dr. George D. Rosengarten is chairman of the finance committee.

The first meeting of the council will be held on Monday, December 28, at 9 A.M. in the council room at Houston Hall. Registration will be held from 9 A.M. to 5 P.M. each day at headquarters in the Houston Club. The sections will meet for organization at 10 A.M. on Monday and will continue their sessions during the week.

The first general session will be held in Weightman Hall, university gymnasium, at 8 P.M. on Monday, December 28. The meeting will be called to order by retiring president Edmund B. Wilson, of Columbia University, who will introduce the president of the meeting, Dr. Charles W. Eliot, of Harvard. Addresses of welcome by the provost and the governor-elect will be replied to by President Eliot, after which retiring President Wilson will deliver his address on "Some Aspects of Progress in Modern Zoology."

There will be two public lectures, complimentary to the citizens of Philadelphia and

vicinity, the one on Tuesday night, at 8 o'clock, being by Dr. Dayton C. Miller on "The Science of Musical Sounds." On Wednesday night, at 8 o'clock, Dr. William H. Nichols will lecture on "The War and the Chemical Industry." The titles of the addresses by the retiring vice-presidents of the sections, to be delivered during the week before the respective sections of the association are as follows:

Vice-president Alfred D. Cole, before the Section of Physics: "Recent Evidence for the Existence of the Nucleus Atom."

Vice-president Henry C. Cowles, before the Section of Botany: "The Economic Trend of Botany."

Vice-president Walter B. Pillsbury, before the Section of Anthropology and Psychology: "The Function and Test of Definition and Method in Psychology."

Vice-president Frank Schlesinger, before the Section of Mathematics and Astronomy: "The Object of Astronomical and Mathematical Research."

Vice-president L. H. Bailey, before the Section of Agriculture: "The Place of Research and of Publicity in the Forthcoming Country Life Development."

Vice-president P. P. Claxton, before the Section of Education: "The American Rural School."

Vice-president O. P. Hood, before the Section of Engineering: "Safety Engineering."

Vice-president Joseph S. Diller, before the Section of Geology and Geography: "The Relief of our Pacific Coast."

Vice-president Theodore Hough, before the Section of Physiology and Experimental Medicine: "The Classification of Nervous Reactions."

Vice-president Judson G. Wall, before the Section of Social and Economic Science: "Social and Economic Value of Industrial Museums."

Vice-president Alfred G. Mayer, before the Section of Zoology: "The Research Work of the Tortugas Laboratory of the Carnegie Institution of Washington."

Vice-president Carl S. Alsberg, before the Section of Chemistry: "Fermentation."

A notable event of the meeting will be the organization of the new Section of Agriculture. Vice-president L. H. Bailey will deliver his address this year, and the new section will hold its symposium at 3 P.M. on Wednesday, December 30, on the subject of "The Field of Rural Economics."

Other symposia will be held as follows: Section B and the American Physical Society at 3 P.M., Tuesday, December 29, on The Use of Dimensional Equations; Section K, at 2.45 P.M., Thursday, December 31, on the subject of Ventilation; at the same time, one will be held by Section F, the American Society of Naturalists, the Botanical Society of America and the Society of American Bacteriologists, on The Value of Zoology to Humanity; and at 11 A.M., Friday, January 1, by Sections C and K on the subject of The Rôle of Nitro-Organisms.

An unusual number of affiliated societies will meet with the association this year and will hold their sessions as indicated in another article in this issue concerning the Philadelphia meeting. The hotel headquarters will be at the Hotel Adelphia, Philadelphia's newest hotel. General headquarters will be at the Houston Club, University of Pennsylvania.

L. O. HOWARD

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Philadelphia, during convocation week, beginning on December 28, 1914:

American Association for the Advancement of Science.—President, Dr. Charles W. Eliot, Harvard University; retiring president, Professor Edmund B. Wilson, Columbia University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.; secretary of the council, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.

Section A—Mathematics and Astronomy.—Vice-president, Professor Henry S. White, Vassar College; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Anthony Zeleny, University of Minnesota; sec-

retary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Provost Edgar F. Smith, University of Pennsylvania; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Albert Noble, New York; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor U. S. Grant, Northwestern University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor Frank R. Lillie, University of Chicago; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. G. P. Clinton, Connecticut Agricultural Experiment Station; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Dr. Clark Wissler, American Museum of Natural History; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Richard Mills Pearce, University of Pennsylvania; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Professor Paul H. Hanus, Harvard University; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor L. H. Bailey, Cornell University; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

The American Physical Society.—Convocation Week. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 29. President, Professor C. R. Mann, Carnegie Foundation, New York City; secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 31. President, Professor Samuel F. Clarke, Williams College; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 29–31. President, Professor C. E. McClung, University of Pennsylvania; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Society of American Bacteriologists.—December 29–31. President, Professor Charles E. Marshall, Massachusetts Agricultural College; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

The Entomological Society of America.—December 31–January 1. President, Professor Philip P. Calvert, University of Pennsylvania; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 28–31. President, Professor H. T. Fernald, Amherst College; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Geological Society of America.—December 29–31. President, Dr. George F. Becker, U. S. Geological Survey, Washington, D. C.; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Paleontological Society.—December 29–31. President, Dr. Henry F. Osborn, American Museum of Natural History, New York City; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Botanical Society of America.—December 29–January 1. President, Dr. A. S. Hitchcock, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 29–January 1. President, Dr. Haven Metcalf, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Fern Society.—December 28–29. Secretary, Charles A. Weatherby, 719 Main St., East Hartford, Conn.

Sullivant Moss Society.—December 30. Secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

American Nature-Study Society.—December 30–31. Secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Alpine Club.—January 2. Secretary, Howard Palmer, New London, Conn.

American Association of Official Horticultural

Inspectors.—December 29–30. Chairman, Dr. W. E. Britton, New Haven; secretary, Professor J. G. Saunders, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Charles Brookover, Little Rock, Ark.; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

The American Anthropological Association.—December 28–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. Secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor R. S. Woodworth, Columbia University; secretary, Professor R. M. Ogden, University of Tennessee, Nashville, Tenn.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The American Association for Labor Legislation.—December 28–29. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

Society of Sigma XI.—December 29. President, Professor J. McKeen Cattell, Columbia University; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

ST. LOUIS

The American Physiological Society.—December 28–30. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor Graham Lusk, Cornell University Medical School; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 28–30. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

CHICAGO

American Mathematical Society.—December 28–29. President, Professor E. B. Van Vleck, University of Wisconsin.

The Association of American Geographers.—December 29–31. President, Professor A. P. Brigham, Colgate University; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

The American Philosophical Association.—December 28–30. President, Professor J. H. Tufts, University of Chicago; secretary, Professor E. G. Spaulding, Princeton, N. J.

PRINCETON

The American Economic Association.—December 28–31. President, Professor John D. Gray, University of Minnesota; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW YORK CITY

The American Mathematical Society.—January 1–2. President, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

SCIENTIFIC NOTES AND NEWS

In addition to the award of a Royal medal to Professor E. W. Brown, F.R.S., for his investigations in astronomy, chiefly in lunar theory, recently announced in Science, the president and council of the Royal Society have awarded a Royal medal to Professor W. J. Sollas, F.R.S., for his researches in paleontology, especially in the development of new methods; the Copley medal to Sir Joseph Thomson, O.M., F.R.S., for his discoveries in physical science; the Rumford medal to the Rt. Hon. the Lord Rayleigh, O.M., F.R.S., for his numerous researches in optics; the Davy medal to Professor W. J. Pope, F.R.S., for his researches on stereochemistry and on the rela-

tions between crystalline form and chemical constitution; the Darwin medal to Professor E. B. Poulton, F.R.S., for his researches in heredity; the Hughes medal to Professor J. S. Townsend, F.R.S., for his researches on electric behavior of gases.

DR. F. SCHLESINGER, director of the Allegheny Observatory, and professor of astronomy, University of Pittsburgh; Mr. W. S. Adams, of Mount Wilson Solar Observatory, and Professor H. Andoyer, professor of physical astronomy in the Sorbonne, Paris, have been elected associates of the Royal Astronomical Society.

PROFESSOR W. H. BRAGG, of the department of physics of the University of Leeds, has been appointed Woodward lecturer at Yale University.

DR. C.-E. A. WINSLOW has resigned from the College of the City of New York to become director of education in the reorganized State Department of Health. His work at the American Museum of Natural History will continue as heretofore.

DR. GEORGE R. LYMAN, professor of botany in Dartmouth College, has been appointed pathologist with the Federal Horticultural Board. Professor Lyman will not remove to Washington until January 1, 1915.

PROFESSOR F. T. TROUTON, D.Sc., F.R.S., has resigned the Quain chair of physics at University College, London, to which he was appointed in 1902.

PROFESSORS WALDEYER, ORTH and others have added their protests to that of Professors Foerster and Verworn against the action of Professors von Behring, Roentgen and others in melting down the medals and renouncing the honors conferred upon them by various scientific bodies in Great Britain.

THE Iron Cross has been awarded to Dr. Walther Nernst, professor of physics in the University of Berlin, who since the death of his son at the front, has joined the automobile corps.

DR. A. WESTERMARCK, of Helsingfors, Finland, and professor of sociology at the University of London, who was to have delivered a series of anniversary lectures at Brown University this winter, will be prevented by the European war from coming to this country.

PROFESSOR L. H. HARRIS, formerly associate professor of the University of Pittsburgh, has been appointed consulting engineer to the Public Service Commission of Pennsylvania.

ASSOCIATE PROFESSOR CHARLES J. CHAMBERLAIN, of the department of botany in the University of Chicago, has recently returned from a botanical trip through Florida and Cuba, continuing the investigations which have already taken him to Mexico, the Hawaiian Islands, New Zealand, Australia and Africa. The recent collecting was done in northern and southern Florida, but chiefly in the western part of Cuba, in the mountains about Herradura, Consolacion del Sur and Pinar del Rio.

PROFESSOR H. C. ADAMS, of the University of Michigan, has returned from China. He was called there one year ago to devise an accounting system for the railroads which the government had taken over. He will resume his work in the department of political economy next semester.

MR. A. FLECK, demonstrator at the University of Glasgow, has been appointed physical chemist to the Glasgow Radium Committee, established to administer a large fund collected in the city for the purpose of acquiring and distributing radium for therapeutic purposes. A radiometric laboratory, under the auspices of the committee, has been fitted up at the university.

DR. FREDERICK G. NOVY, professor of bacteriology in the University of Michigan, lectured before the Science Club of the State Normal College at Ypsilanti, on November 23, on the foot and mouth disease which is now prevalent in Michigan.

DR. JOHANNA WESTERDIJK has given five lectures before the students of plant pathology in the University of Illinois. The subjects of her lectures were as follows: Tropical Plant Diseases; Potato Vine Diseases; Potato Tuber Diseases; Fruit Diseases in Europe and America; Some Problems in Plant Pathology and Methods of Meeting Them.

During the week ending November 14, Professor George Grant MacCurdy lectured twice for the Pittsburgh Academy of Science and Art, once at Swarthmore College, and once for the Hartford (Conn.) branch of the Archeological Institute of America.

A portrait of the late Director E. A. Fuertes which was presented to the university by the alumni of the College of Civil Engineering of Cornell University was accepted by the trustees on November 7. It was resolved that, in accordance with the suggestion of the donors, the portrait hang in the office of the college in Lincoln Hall.

A bust of the late Professor Leuckart, the well-known zoologist, has been presented by his widow to the University of Leipzig.

Dr. Theodor Lipps, professor of psychology and philosophy at the University of Munich, has died at the age of sixty-three years.

Dr. Rudolf Emmerich, professor of hygiene and bacteriology in the University of Munich, has died at the age of sixty-two years.

Mr. Douglas S. Martin, at one time on the editorial staff of *The Electrical World*, who left New York in August to enroll in the mounted forces of Great Britain, has died in the Bolougne Hospital from shrapnel wounds received at the battle of Messines, on the Belgian border.

We learn that Dr. Hermann Strebel, widely known on account of his researches in anthropology and malacology, especially of Mexico, where he was long a resident, died at Hamburg, Germany, on November 6, in his eighty-first year. His scientific activities continued almost to the time of his death.

The death is also announced of Dr. J. Borgmann, professor of physics in the University of Petrograd, and author of works on electricity and magnetism.

Dr. Emile Reymond, the distinguished French surgeon and senator of the Department of the Loire, has been killed while reconnoitering in an aeroplane above the German lines. Dr. Reymond was born in 1865, the son of the eminent engineer, Francis Reymond.

The deaths of scientific men who had been with the German army at the front are announced as follows: Dr. R. Stumpf, docent and first assistant in the Pathological Institute of the University of Breslau; Dr. Franz Velisek, professor of mathematics in the Technical Institute at Prague; Dr. G. Paur, docent for statistics in the Royal Academy at Posen; Dr. Franz Marshall, director of the experimental laboratory of the Agricultural Institute of the University of Halle; Dr. Constantin Guillemaup, docent in geology in the Technical School at Aix, and Dr. Oswald Loeb, docent for pharmacology in the University of Göttingen.

The *British Medical Journal* states that the German medical staff has already suffered very severely in the present war. Up to the middle of October 135 medical officers were reported killed, wounded or missing, 74 of these having been killed. Among them is Friedrich König, professor of surgery in the University of Marburg, and son of the late Professor Franz König, of Berlin; he was killed in action at the eastern seat of war. In the entire Franco-German war of 1870–71 only 11 German surgeons died on the battlefield or from wounds there received. According to the *Berliner med. Wochenschrift* of October 19, the decoration of the iron cross had then been bestowed on 120 medical officers.

The anniversary dinner of the Royal Society, usually held on St. Andrew's Day, will not take place this year. The council of the Physical Society of London has also decided not to hold its annual exhibition of physical apparatus.

The Western American Phytopathological Society will hold a meeting at Corvallis, Oregon, on December 28, 29 and 30. This society was organized at the State Fruit Growers' Convention at Davis, California, last spring, and, while its principal aim is to discuss matters of technical plant pathology, practical

features will also receive considerable attention. All persons interested in this subject are cordially invited to attend the meetings. Further information concerning the meeting may be had by addressing the secretary of the society, Wm. T. Horne, University of California, Berkeley, California, or Professor H. S. Jackson, Corvallis, Oregon.

UNIVERSITY AND EDUCATIONAL NEWS

THE newly founded university at Frankfurt a. M. has been opened as planned, having enrolled Edinger, Ehrlich, Embden, B. Fischer, Göppert, Herxheimer, Neisser, Rehn and others. Kaiser Wilhelm is said to have signed the statutes of the university on the historic date, August 1. Austria-Hungary has also just founded a new university, the fifth in the empire. It is located at Presburg, in Hungary, about 40 miles east of Vienna. It was inaugurated with simple ceremonies on October 4.

IT will be remembered that after the fall of Louvain and the destruction of the university and its library, the University of Cambridge formally invited the Louvain professors and students to transfer their university to Cambridge, and, as far as it might prove possible to do so in a foreign land, to carry on their teaching and examining. After some time it became apparent that the authorities of the Belgian university did not see their way formally to accept. This, however, has not prevented steps from being taken for the formation of unofficial courses, which are being conducted by the following professors: Dr. Arien, Louvain; Professor Breithof, Louvain (graphics); Professor Carnoy, Louvain (Greek); Professor Colson, Liége (chemistry); Professor Corbiau; Professor Déjace, Liége (law); Dr. Devigne, Liége (law and philosophy); Professor Léon Dupriez, Louvain (law); Professor Van Gehuchten, Louvain (neuropathology); Professor Gillet; Professor Van Hecke, Louvain (engineering); Professor Canon Van Hoonacker, Louvain (theology); Professor de La Vallée-Poussin, Ghent (Sanskrit); Professor Steels; Professor Van den Ven (Byzantine Greek).

THE University of Glasgow has offered academic hospitality to accredited teachers and students of Belgian universities who have taken refuge in Glasgow. The heads of the several departments will afford them such facilities for study and research as it may be found practicable to provide.

PLANS are practically completed for the construction of the Anthony N. Brady Memorial Laboratory of the Yale Medical School. The laboratory and administration building will be erected early in the spring of 1915.

DR. JAMES ROWLAND ANGELL, who is head of the department of psychology and dean of the Faculties of Arts, Literature and Science in the University of Chicago, has declined the offer of the presidency of the University of Washington at Seattle.

MR. L. R. FORD, of Harvard University, has resigned, on account of the war, the Sheldon fellowship on which he was to have studied abroad, and has accepted a lectureship in mathematics at the University of Edinburgh.

PROFESSOR WILLIAM MARSHALL, on leave from Purdue University, has returned from Europe and has been appointed assistant professor of mathematics in the University of Arizona for the year 1914–15.

DR. RUDOLPH H. KOCHER has been appointed instructor in research medicine in the Hooper Foundation of Medical Research of the University of California, Berkeley.

DR. A. H. LOTHROP, formerly of Columbia University, has been appointed professor of biological chemistry in Queens University, Kingston, Ontario.

DR. WALTER RAMSDEN, senior demonstrator in physiology at Oxford University, has been elected to the *Johnston chair of bio-chemistry* at Liverpool University rendered vacant by the resignation of Dr. Benjamin Moore.

THE vacancy in the chair of chemistry of the University of Aberdeen, caused by the retirement of Professor F. R. Japp after twenty-four years' service, has been filled by the ap-

pointment of Mr. Frederick Soddy, formerly lecturer in physical chemistry and radioactivity, in the University of Glasgow; Professor Theodore Shennan, pathologist to the Royal Infirmary of Edinburgh and lecturer in the university will succeed Professor George Dean in the chair of pathology.

DISCUSSION AND CORRESPONDENCE

MINUTE ANIMAL PARASITES

To the Editor of Science: We have to thank you for inserting a review of our book, "Some Minute Animal Parasites" in your issue of July 17, pp. 105–107, and now ask the favor of your columns for the purpose of correcting certain inaccuracies contained therein. Unfortunately, the reviewer has made rather numerous inferences not to be found or suggested in the original. and seems to have mistaken an account of life-histories of certain parasitic Protozoa for a text-book of the type dear to the systematist. Both space and time prevent us doing more than indicate a few of the lapses from accuracy in the review, but mention of certain of these is essential.

The review states:

1. The fourth chapter deals with the spirochætes in a manner ''which shall be as non-controversial as possible, and which will consist of facts and not the speculations so fashionable nowadays.'' The authors adhere so consistently to this promise that the reader would never know from the text that thousands of others have worked with these organisms.

Excluding the hyperbole regarding the thousands of workers on the subject, we quote in that chapter the works of Balfour, Blaizot, Blanc, Breinl, Certes, Conseil, Doflein, Dutton, Ehrenberg, Hindle, Leishman, Markham, Carter, Moebius, Nicolle, Perrin, Prowazek, Schaudinn, Todd, Zuelzer and ourselves, and give the opinions of other investigators also.

2. He would also look in vain for a description of the spirochæte of syphilis.

A reference to p. 86 not only gives the correct name of the organism (*Treponema pallidum*), but at least ten lines of special statement regarding it. There is also an entry in the index on p. 318.

3. The sixth chapter, dealing with coccidiosis . . . omits even a reference to coccidiosis in man.

It is regrettable that p. 117 was not noticed, for it is there stated that

The human parasite is possibly the same as that which infests rabbits, and there is the likelihood that the eating of the livers of rabbits suffering from coccidiosis has resulted in its transference with fatal results to the human host.

There is further reference to *Eimeria stiedæ* on pp. 139–140 of the book.

4. Regarding classification, the book was never intended to be a text-book for systematists and we state definitely on p. 18 that we "select material presenting as much variation as possible . . . without reference to strict schemes of classification." There is no need, then, for adherence to taxonomy. The suggested arrangement by systematic treatment according to mode of infection is impracticable because of lack of detailed knowledge in many cases. However, the principal known modes of infection among the Protozoa, with examples, are given in the first chapter of the book, on pp. 4–10.

The ungenerous concluding remark in the review, is, we feel, best ignored. We have already mentioned in this letter the numerous authors to whose work reference is made in Chapter IV., and a similar condition obtains elsewhere. We can only say that we have endeavored to do justice to all so far as the limits of a book of this kind would allow. This fact has received outside recognition generally, and we may quote the opinion expressed in the well-known English journal *The Lancet*, June 27, 1914, p. 1819, where it is stated that

We may note that everywhere the authors of the book under review are careful to give honor where honor is due.

In conclusion, we may add that we endeavored to appeal not only to students of science, but also to the class of educated persons whom the technicalities and terminology of the systematist have hitherto repelled.

H. B. Fantham,
A. Porter

Cambridge, England

THE REPLY OF FANTHAM AND PORTER

It is regrettable certainly that books submitted for review do not always meet with unqualified commendation. Any such book is an objective thing to be treated critically and impartially by the unprejudiced reviewer and the impression made by the book upon the reviewer should be honestly set forth by him. This was the case in the present instance and the concluding remark which the authors feel it best to ignore, was the honest impression made by the book upon the reviewer. As it was an impression made on a reader unacquainted with the authors but familiar with the subjects discussed, the fault must lie in the book.

As for the so-called inaccuracies in the review I will not take the space here to go over the matters which led to the criticisms but will point out some misleading statements in the authors' letter. For example the rather imposing list of names in connection with spirochætes does not include such careful observers as Novy, Gross or Dobell, whose views regarding so-called longitudinal division are quite different from those of the authors. These are probably included in the "opinions of other investigators also," an example of which, in connection with spirochaetes, may be cited from page 71:

> Again, some persons have denied the existence of longitudinal division because they themselves have not observed it. Needless to say, their misfortune does not invalidate the fact of undoubted longitudinal division.

Equally misleading is the reference (2) to *Treponema pallidum*, the spirochæte of syphilis. It is true that the Index on page 318 refers to all that is given on the subject, and we quote it in full:

> The parasite of syphilis was first regarded as a spirochæte, but later was renamed *Treponema pallidum*, because the coils of the body were said to be fixed. Balfour recently has shown that *Treponema* is a "granule shedder," *i. e.*, it produces ovoid bodies just as spirochætes do. In this case it seems very probable that it is only the minuteness of the organism that prevents full knowledge of its internal structure, and that for the same reason its coils appear fixed. There are undoubted affinities between all of the organisms mentioned, and it seems far better to keep the older nomenclature and not to attempt re-classification until the life-history of each form has been fully elucidated. Building on an insecure foundation has the disadvantage of causing endless patching and emendation later, and the old saying, "More haste, less speed," is as applicable in protozoology as elsewhere (p. 86).

This certainly justifies the criticism in the original review, for even the authors would hesitate to claim that this is a description of the organism of syphilis.

GARY N. CALKINS

A FILEFISH NEW TO THE ATLANTIC COAST OF THE UNITED STATES

WOODS HOLE continues to yield most unexpected ichthyological treasures. The latest addition to the fish fauna of the region is a filefish taken in floating rockweed in Vineyard Sound on September 3, 1914, by Mr. Vinal N. Edwards, the indefatigable collector at the fishery station. The species is *Cantherines pullus*, described in 1842 from Brazil and subsequently taken in Cuba, Porto Rico and Tortugas, but heretofore unknown from the east coast of the United States. The genus *Pseudomonacanthus* Bleeker, 1866, appears to be identical with *Cantherines* Swainson, 1839; and *Pseudomonacanthus amphioxys* (Cope), known only from two young specimens from St. Martin Island, West Indies, is a synonym of *Cantherines pullus* (Ranzani).

My associate Mr. Lewis Radcliffe advises that a comparison of the Woods Hole specimen and another of the same species from Porto Rico with a specimen of the type species of this genus, *Cantherines sandwichiensis* (Quoy and Gaimard), from Honolulu discloses no valid differences. As the latter is recorded from Socorro Island, off the west coast of Mexico, and the young are pelagic, it seems not improbable that a further comparison of a series of specimens from widely separated localities will prove *pullus* to be a synonym of *sandwichiensis*.

H. M. SMITH

BUREAU OF FISHERIES,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

Introductory Geology, a Text-book for Colleges. By THOMAS C. CHAMBERLIN and ROLLIN D. SALISBURY. New York: Henry Holt & Co. 1914. Pp. xi + 708. $5\frac{3}{4} \times 8$ inches. Price $2.00.

In comparison with this latest product by geologist and printer there stands before the writer a long row of early treatises and texts in geology, American and English, dating from the early part of the last century. The contrast is great, both in matter and illustrations. These old books seem very crude and it is difficult for us to realize the limitations of scientific thought before Lyell showed the uniformity of nature's processes and laid in physical evolution the foundation for biologic evolution. Much space in the older books is used in proof of matters which are now common knowledge of educated people, and the illustrations are ludicrously poor. Even to fifteen years ago publishers tabooed photographic reproductions and regarded hand engraving as the only artistic and proper illustration. Modern photography has brought the far-away geologic and physiographic features to the secluded student, and thus qualified the aphorism that the first, second and third requisites of the geologist are travel.

From 1840 to 1860 the leading text-book in geology was that of Edward Hitchcock, which in 1860 had run to the 30th edition. The civil war distracted attention from scientific studies and for many years the only prominent book in geology was Dana's Manual, on which the older geologists now living were nurtured. Up to about 1900 the works of Dana and LeConte had fair possession of the schools. Chamberlin and Salisbury's geology in three volumes was published in 1905–1906, since which time the new books in geology and physiography "speak volumes" for the popular interest in earth science. Much of this regard may be traced to the popularizing of physiographic geology, led by Davis. The profuse photographic reproduction of natural features has been a stimulant to the magazine readers and encouragement to the authors and printers, while the commercial world has been interested through the economic study of the earth now specially emphasized by the national and state geologic surveys.

The book under review is the latest word (to-day) in general geology and probably the finest example of the bookmaker's art in works of the class. A duodecimo volume of 700 pages is made of practical size by the use of thin, fine-quality paper of medium finish. It was wise to change from the heavy, highly glazed paper used in the three-volume work and to sacrifice a trifle of the quality or clearness of the halftones and the maps, for the gain in other respects. By not wasting space on wide margins a four-inch measure is secured for the excellent letterpress. As in the larger work, the insets carry impressions on both sides. The 10-point type, wide measure, with forty lines to the page, coupled with the condensed style and brief treatment of less important topics, has produced a book of reference value in practical size for students' use. The general arrangement of the matter is in the usual order.

It will be generally conceded that the senior author has preeminence in America in philosophic geology. Consequently the book will be recognized as a very high authority, especially on the philosophic or theoretic side. As should be expected with this authorship there is much original matter, though some of the text and most of the illustrations are derived from the same authors' larger work. The text is in their characteristic terse and rather technical style. They do not attempt the impossible task of making geology simple and easy to the average college student.

No competent teacher will find in this book everything that he wishes nor all that he needs with the proper emphasis for his particular region. The body of geologic knowledge has become so vast that a single volume can do no more than generalize. The physiographic, geologic and climatic characters are so very different in the several provinces of America that no book of practical size and moderate cost can adequately present the special or local features. For example: over great areas of our northern lands the glacial phenomena are

the most obtrusive and available for study; in the Appalachian region and other mountain districts the structural or tectonic features are the more striking; in the Great Basin and over the southwestern plateaus the factor of aridity; in some districts, vulcanism; etc. The stratigraphic and paleontologic differences of the several sections are quite as important. Some one has said that the best conversation goes on in hints, and a text-book for nation-wide use must be merely suggestive on many subjects. The competent college instructor must be capable of making his own text-book for his own district. The tendency of general text-books and treatises will be to omit more and more of the elementary matter as it becomes the common knowledge of educated people, and another class of books will arise for observational and intensive study of particular provinces.

To point out minor omissions, slips or errors is both ungracious and unnecessary, and few are found in this book. One broad criticism will be made of the references to collateral literature and contemporary authors. The book does not make the mistake of loading its pages with a multitude of references. But when they are used at all they should be discriminating, impartial and up-to-date. Although there are abundant references to the publication of the U. S. Geological Survey and to the *Journal of Geology,* there are comparatively few references to other literature, and very few to articles of the last ten years. Yet the geologic literature of the last decade is large and much of it of masterly character, by eminent authorities, superseding for reference value much of the older writings. The geologists of the eastern states may feel that the book has a provincial character.

This book will be welcome to those who wish a geologic philosophy based on a scientific theory of the genesis of the globe. An admirable summary is given of the three hypotheses of earth origin; the Laplacian ("Nebular"), Lockyer's meteoritic and Chamberlin's planetesimal. The manner of the earth's origin is the basal postulate in all geophysical theories and in most geologic philosophy. On very many subjects the views of the geologist and his handling of problems must ultimately be grounded on his conception of the origin of the globe and its satellite. As all geologists up to recent years, and many of the more conservative at the present time, still hold to the discredited hypothesis of an originally incandescent globe, it will be seen that this work, like its three-volume predecessor, runs counter to many long-accepted theories and presents new and novel explanations.

In true scientific spirit and with some deference to conservatism, the authors have been fair in treatment of old theories and modest in presentation of the new views, usually setting the older thought side by side with the new philosophy. A few of the topics which have original treatment, in consequence of the new cosmogeny, are: origin and nature of the deep-seated rocks; origin of the ocean and the atmosphere; origin of the sub-oceanic and continental relief; diastrophism and mountain structure; vulcanism; duration of life; climatic changes; subdivision of Precambrian time. Ore deposits are given a fair presentation under the topic "Groundwaters." The chemic and biologic processes of the ocean are given space instead of long description of the commonplace erosional work.

The historical portion of a text-book is the most difficult to handle. Selection and condensation must be made from a vast body of paleontologic fact and from uncertain or conflicting stratigraphy. And such matter is the most difficult to keep up-to-date and to make satisfactory to the experts. In general, this matter of the book seems judicious and well balanced, but the New York stratigraphy is too old. Under the Silurian the curious mistake of Hall, Emmons and Dana in placing the Oneida conglomerate beneath the Medina, instead of above it, is repeated, although the correction was made years ago in the New York State Museum publications, and in Science.

The series of paleogeographic maps, depicting the evolution of the continent, are copied with some reduction from the three-volume work.

It would seem desirable that, for comparison, reference should have been made to the extended series of similar maps recently published by Schuchert, and also to the series by Willis; especially as the three sets of maps show very different conceptions of the ancient epicontinental seas.

This book is probably the most comprehensive, original and suggestive of any single volume in geology now printed.

H. L. Fairchild

The University of Rochester

Technical Mechanics. By Edward R. Maurer, Professor of Mechanics in the University of Wisconsin. Third edition, rewritten. New York, John Wiley and Sons, 1914.

Maurer's "Technical Mechanics," of which the first edition was published in 1903, has a recognized position among useful text-books for students of engineering. The reprints previous to the present or third edition contained few changes; but practically the whole book has now been rewritten. The aim of the author, however, remains unchanged, the words of the original preface describing the book as "a theoretical mechanics for students of engineering" being again used as applying to the present rewritten edition. It has been the author's object to "furnish an adequate course of instruction for students of engineering in one semester, five times per week." The recasting for the present work has involved not only changes in arrangement and form of presentation, but some changes in subject-matter, such as the omission of the chapter on attraction and stress and some amplification of rigid-body dynamics. The scope and order of the work are indicated by the chapter headings: Composition and resolution of forces; forces in equilibrium; simple structures; friction; center of gravity; suspended cables; rectilinear motion; curvilinear motion; translation and rotation; work, energy, power; momentum and impulse; two-dimensional motion; three-dimensional motion; appendices on theory of dimensions of units and moment of inertia of plane areas. Especially worthy of note are the twelve pages in the chapter on momentum and impulse devoted to a lucid explanation of gyroscopic action and its applications to the gyrocompass, the mono-rail car, the gyro-stabilizer for ships, and the self-steering torpedo. A wholly new collection of problems is given, most of which are collected at the end of the book, thus avoiding interruption of continuity of exposition in the text. The illustrations, more than 500 in number, are executed with notable care.

Those who know the original edition need not be told that the author's presentation is, with few if any exceptions, sound, and that a notable quality of his exposition is conciseness without sacrifice of logical accuracy or completeness. Some teachers may perhaps think the virtue of conciseness is at times carried so far as to make the book unduly difficult reading for the beginner. The many teachers who have successfully used previous editions will, however, undoubtedly find the rewritten work even more satisfactory.

In reviewing the first edition[1] of this book, the writer took occasion to discuss certain questions regarding the presentation of fundamental principles of dynamics. At the present time special interest attaches to Professor Maurer's presentation of principles because of his position as chairman of the committee on the teaching of mechanics appointed in 1913 by the S. P. E. E. The appointment of this committee seems to have been due largely to certain rather vigorous criticisms of current methods of presenting fundamental principles, especially the "fundamental equation of dynamics" and the definitions of units of force.

Professor Maurer uses the equation $F=ma$, but his explanation of it makes it seem subsidiary to the equation $F/W=a/g$, or $F=(W/g)a$; the latter equation being explained as a special case of $F/F'=a/a'$, where a, a' are the accelerations due to forces F, F' acting on the same body at different times. In order to pass from the equation $F=(W/g)a$ to the equation $F=ma$ (or $F=Kma$ if units are unrestricted) use is made of the fact that different bodies in the same locality are equally accelerated by gravity. In the view of the

[1] Science, Vol. XXI., p. 302.

present writer this procedure is not strictly sound as a scientific explanation of the equation $F = Kma$. The presence of the mass constant in the equation should rather be accepted as an ultimate part of the laws of motion, while the facts of gravity are wholly apart from those laws. This is in fact elsewhere recognized by the author in his apparent acceptance of Newton's laws (p. 155) as the scientific basis of dynamics.

Although Professor Maurer's procedure described above seems to lend some countenance to the position of those who call the equation $F/F' = a/a'$ the "fundamental equation of dynamics," it is not likely that he really accepts this view; probably his order of presentation was dictated by pedagogic considerations. An equation which results from comparing the effects of different forces *upon the same body* can not, of course, be regarded as a complete expression of the fundamental law of motion; it is equally important to compare the effects of forces *acting upon any different bodies.* This of necessity brings in the body-constant which most physicists call mass. If an equation is used which does not contain this quantity explicitly, it must be implicitly taken account of in the application.

As a matter of fact it is difficult to understand the antagonism which some critics have shown for the equation $F = ma$. The main alleged objection to it appears to be the fact that it requires units to be properly chosen; but this is true of most of the equations used to express physical laws or facts.[2] One who really understands the fundamental principle of dynamics will have no difficulty in understanding the equation $F = ma$, or in remembering that it implies that units are so defined that unit force acting on unit mass causes unit acceleration.

To the present writer it seems that the real meaning of the fundamental equation of dynamics is most clearly brought out by presenting it first in the form of a compound proportion,

$$\frac{a}{a'} = \frac{F}{F'} \cdot \frac{m'}{m},$$

in which a is the acceleration due to a force F acting on a mass m and a' the acceleration due to a force F' acting on a mass m'. From this it is easy to pass to the equation $F = Kma$ for any arbitrary set of units, and then by a certain choice of units to the equation most commonly used because simplest, $F = ma$. Substantially this method of presentation was given in the first edition of Professor Maurer's book, but seems to have been omitted from the present edition.

As regards units of force, Professor Maurer's practise is the usual one among engineers. For ordinary use the pound-force or kilogram-force is adopted as unit, with the explanation that although this unit varies with locality, the variation is so slight as ordinarily to be of no practical importance. Although remarking that the pound-force can be made definite by specifying a standard locality, the author does not urge the general adoption of such a standard unit, but follows common scientific usage in adopting a kinetic definition of the absolute unit of force. This definition is, of course, based upon the fundamental principle of which the equation $F = ma$ (or $F = Kma$) is an expression. This principle being assumed, it is possible to define the unit force as that force which would give some definite mass some definite acceleration; the common practise being to take as unit the force which gives the (arbitrarily chosen) unit mass the (arbitrarily chosen) unit acceleration,[3] thus

[2] It is true, for example, of the equation usually employed to express the law of gravitation. It is true also of the simple equation $A = L^2$, where A is the area of a square of side L. In fact it is not easy to cite equations practically used in applied mathematics of which it is not true. The only way to avoid the alleged objection is to throw every such equation into the form of a proportion.

[3] It is worthy of remark that the advocates of the adoption of a standard pound force, though ostensibly defining it as the weight of a pound body at a standard locality, in reality define it as the force which would give a pound body (meaning a body whose mass is a pound) the acceleration 32.1740 ft./sec^2. Thus the real definition is of the same kind as that of the dyne, and the standard pound-force is really a "kinetic" rather than a "gravity" unit.

reducing the fundamental equation to its simplest form $F = ma$. The author points out also that it is possible to vary the procedure by choosing arbitrarily the unit force and adopting a kinetic definition of the unit mass; and he uses the word "slug" to designate the mass to which the pound-force would give an acceleration of 1 ft./sec^2. His explanation of this matter seems to the writer to be entirely sound, as well as being an aid to the student in acquiring a clear understanding of the fundamental law.

The entire treatment of force and of the laws of motion is notably free from the vagueness which too often characterizes the exposition found in text-books. The words push and pull are freely used, and the fact is explicitly stated at the outset that every force is exerted *by* one body *upon* another body. The law of action and reaction is stated in the following words: "When one particle exerts a force upon another, then the latter exerts one upon the former; and the two forces are equal, colinear and opposite." Most of the difficulty that arises over this law is due to losing sight of some one or more of the facts that are here explicitly stated. If it is kept clearly in mind that an action and its reaction (*a*) always concern two bodies and only two and (*b*) never act upon the same body, there is little difficulty in avoiding the confusion that is often associated with such terms as "inertia-force" and "kinetic reaction."

L. M. Hoskins

Stanford University

Principles of Electrical Measurements. By Arthur Whitmore Smith. New York: The McGraw-Hill Book Company, 1914. Pp. xiv + 343.

In a laboratory course, emphasis may be laid by one teacher on manipulation and details of apparatus and, by another, on the principles underlying the methods employed in making the measurements. Professor Smith does the latter and has developed a text that is suitable for classroom as well as laboratory. The book is written for the instruction of those who are beginning their course in electrical engineering or who desire a more complete understanding than is afforded in most elementary manuals. It shows thoroughness and care in its preparation. In addition to a discussion of subject-matter usual in a laboratory manual of this kind—as ammeter and voltmeter methods; use of the galvanometer, bridge and potentiometer; measurement of current, power, capacity and inductance; magnetic tests of iron and steel—the author includes chapters on electromagnetic induction, on the definition of the Maxwell and on alternating currents, which, while not essential for one only interested in the taking of readings, lead the student to a better understanding of the subject as a whole.

Frederick Bedell

A Manual of Bacteriology for Agricultural and Science Students. By Howard S. Read. Ginn & Co. $1.25.

This little manual of 179 pages contains a collection of experiments, descriptions of methods, formulæ for media and reagents, and other information of practical use in a bacteriological laboratory. It is intended as an outline of a course for students, but it would be quite difficult, indeed, practically impossible, in an ordinary laboratory, for a student to follow this course consecutively, since the experiments described follow each other in an order that, while logical for study, would be almost impractical to carry out in a laboratory class. As a result the student can not follow the course without very careful thought and selection of experiments on the part of the teacher. The book is therefore more valuable for a manual for reference than as a distinct course for students to follow. It contains large numbers of experiments, and if properly used can be made of great use as a foundation of a course in bacteriology. It is more complete, more up-to-date, and contains more of the recent additions to bacteriological methods than the other manuals which have been published in the last few years. It is made more valuable by having in addition to methods strictly bacteriological some which are especially designed for the study of yeasts, and of common molds. While the methods are

in general simply described, in some cases difficult technique is passed over with a few words of description, so meager as to make it almost impossible for the student to follow them without very close supervision on the part of the instructor. For example, it is doubtful whether a student could ever obtain a pure culture of yeasts by the method described without having an instructor at hand to show him every detailed step. The numerous experiments also imply the possession on the part of the instructor of a large amount of material commonly not at hand in a bacteriological laboratory, especially in the way of cultures of various organisms, and no direction is given as to how these may be obtained.

In a little book of this kind not all laboratory methods can be included, and some omission may be well excused. Some of the omissions are a little unfortunate. For example, in describing the detection of nitrites, the method that is commonly used, of inoculating bacteria into nitrate broth is not given at all, the only method given depending upon synthetic media. The common use of nitrate broth, included in the standard methods, should certainly have been among the methods given in this little manual. On the whole, the manual is useful, and can be recommended as an up-to-date reference book of laboratory methods.

H. W. CONN

WESLEYAN UNIVERSITY

The Elements of Psychology. By DAVID R. MAJOR. Revised Edition. Columbus, R. G. Adams & Co. 1914. Pp. 413.

Much difficulty has been experienced in recent years in preparing a satisfactory text for introductory college courses in psychology. Possibly the difficulty arises from the fact that the customary elementary course in psychology—unlike that in other sciences—aims less to initiate the student into the use of a set of special methods and a body of knowledge obtained by their application, than to interpret and rationalize what everyone is more or less acquainted with from common experience. Evidently more tact and literary skill are required to treat what is already familiar in a profitable way, than to launch out into what is new to the student. However this may be, there have certainly been a large number of attempts to meet the felt need for an elementary text, and few of the attempts have given much satisfaction. The present book is another experiment in this direction, and appears likely to prove unusually successful. If it makes no great claim to originality of teaching, and has no special axe to grind, and if it lacks somewhat in incisiveness, these are defects which the student can readily overlook in view of its well-sustained effort to meet him on his own ground. Granted that the introductory course is to be kept within its traditional bounds, this text should make a very satisfactory guide.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

SCIENTIFIC JOURNALS AND ARTICLES

Terrestrial Magnetism and Atmospheric Electricity for December contains the following articles: "The Free and Forced Vibrations of a Suspended Magnet" (concluded), H. F. Reid; "Magnetic Declinations and Chart Corrections obtained by the *Carnegie* from Bahia, Brazil, to St. Helena, May 20 to June 22, 1913," L. A. Bauer and W. J. Peters; "On Certain Matters relating to the Theory of Atmospheric Electric Measurements," W. F. G. Swann; "Investigation of Certain Causes Responsible for Uncertainty in the Measurement of Atmospheric Conductivity by the Gerdien Conductivity Apparatus," C. W. Hewlett; "Magnetic Declinations and Chart Corrections obtained by the *Carnegie* from Hammerfest, Norway, to Reykjavik, Iceland, and thence to Brooklyn, New York, July to October, 1914," L. A. Bauer and J. P. Ault; Letters to Editor: "Principal Magnetic Storms recorded at the Cheltenham Magnetic Observatory, July–September, 1914," O. H. Tittmann; "Umbau an dem Schulze'schen D-Variometer des Observatoriums in Tsingtau," B. Meyermann.

NOTES ON METEOROLOGY AND CLIMATOLOGY

MOUNTAINS AND WINDS

A RECENT paper by Th. Hesselberg and H. U. Sverdrup, entitled, "Über den Einfluss der Gebirge auf die Luftbewegung längs der Erdoberflache und auf die Druckverteilung,"[1] includes studies of the Appalachians, Alps and Apennines as influencing winds. For the United States 51 weather maps in 1906 were chosen for study. The winds of the Appalachian region exhibit three simple types of influence. (1) With a general flow of air from the northwest there is divergence on the windward side and convergence on the leeward side of the mountains. (2) With a southeast wind there is the same general flow of air around the mountain mass but locally there are converging winds on the windward side. This is said to indicate an air whirl on a horizontal axis there. (3) When there is a general southwest wind parallel with the mountain chain, the winds over the mountains are usually across them from the west. But when the flow is from the northeast, there are no such corresponding winds crossing the mountains. These cross west winds are apparently due to the influence of the upper prevailing westerlies.

Stronger and more complex, mountain influence on crosswise and lengthwise winds was found in Europe, both because of the greater altitude of the mountains and because of more observing stations. With strong cross-mountain flow of air the atmospheric pressure is raised to windward and lowered to leeward, in addition to changes wrought in the wind direction. Cool, wet weather to windward and warm dry weather to leeward followed as a result of the dynamic changes in temperature experienced by the wind in crossing the mountains. In winter locally the mountains become high-pressure, divergence points; while over the valleys low pressure and convergence is the rule. In summer the weather maps indicate a partial reversal of these conditions, since frequently by the time the observations are taken, the diurnal heating of the valleys has already started the up-valley breezes. Thus the wind directions in and about a mountain region are strongly controlled by the presence of the mountains.

[1] Veröff. des Geophys. Inst. d. Univ. Leipzig, 2te Serie, heft 4, Leipzig, 1914, pp. 102–116, 2 pl.

THE INFLUENCE OF METEOROLOGICAL CONDITIONS ON THE PROPAGATION OF SOUND

THIS study by Dr. H. Bateman[2] includes the effects of wind, temperature, moisture and air composition on the propagation of sound. The general influence of any wind is to reduce the audibility of sounds. The usual greater range of a sound with the wind than against it is ascribed to the increase of wind velocity with altitude, which bends upward the sound waves traveling against the wind and downward those going with the wind. On the other hand, if the upper wind is opposite to the lower one, a sound refracted upward in traveling against the surface wind may be bent to the earth again on entering the other current. This may account for the peculiar regions of silence and sound often observed in easterly surface winds. If the transition from one air current to another is sharp, the boundary may become a reflecting surface.

The temperature effect on sound is much like that of the wind. In the daytime, the normal vertical decrease in temperature leads to refraction of sound waves upward, and the lack of thermal homogeneity of the air aids in dispersing sounds. At night or in cloudy weather, when the temperature is more uniform, sounds are more easily heard. Apparently the lower surface of the stratosphere acts as a reflecting surface which returns to earth heavy sounds such as from artillery fire or volcanic explosions, making spots where such sounds are heard far beyond the limits of direct audibility.

Sounds entering moist masses of air are weakened by "stifling," refraction, scattering and perhaps reflection. Fog usually produces peculiar sound effects, probably on account of temperature differences in the fog

[2] *Monthly Weather Review*, May, 1914, pp. 258–265, 1 fig.

and perhaps also because of sound reflection from the upper limit of the fog. Local interference resulting from such reflection may explain the silent regions so commonly observed in connection with fog signals.

In a similar way, the boundaries between air bodies of different temperatures and humidities in thunderstorms are important in prolonging thunder[3] and in preventing the sound from traveling great distances.[4]

THE THUNDERSTORM AND ITS PHENOMENA

PROFESSOR W. J. HUMPHREYS under the above title has published[5] a careful summary of the present knowledge relative to thunderstorm physics and has added many new points. Professor Humphreys recognizes five types of thunderstorms, which occur as follows: (1) in regions of high temperature and nearly uniform pressure (heat thunderstorms); (2) in the southeast quadrant of an almost circular cyclone; (3) between the branches of a V-shaped cyclone; (4) in the trough between two anticyclones; (5) on the boundary between warm and cold waves. All but the first are produced essentially by the over- and under-running of winds of different temperatures, which in some way cause moist air masses to rise. Each of these types is illustrated with a set of three successive weather maps at 12-hour intervals.

The squall-wind associated with thunderstorms is thought to be the outward flow from a cataract of air which is cooled and kept cold in its descent by the rain or hail falling through it. The sudden rise in air pressure at the onset of a strong thunderstorm is ascribed to the combined effect of the downward thrust, greater density and relatively small absolute humidity of this cold wind, and to the interference which the thunderstorm offers to the free flow of the general winds.

The splitting of raindrops in falling through the ascending air currents characteristic of thunderstorms is, according to G. C. Simpson, the source of the lightning. The small drops with negative charges go up with the wind while the larger ones with positive charges stay below. Thus in a thunderstorm there is usually a region of positive electricity between the negative earth and the negative upper portion of the cloud. When the charge becomes sufficient to ionize a path through the air, a series of direct current discharges usually take place along approximately the same line. A progressive lengthening of a lightning streak in its successive six discharges is shown in a picture taken with a rotating camera (Fig. 26). Professor Humphreys is to be congratulated on his thorough and simple presentation of such a difficult subject.

[3] W. Schmidt, *Meteorologische Zeitschrift*, January, 1914, pp. 33–37.

[4] W. J. Humphreys, *Monthly Weather Review*, June, 1914, p. 379.

[5] *Ibid.*, pp. 348–380, 28 figs.

RAINDROP VELOCITIES[6]

J. LIZNAR in deriving a new mathematical formula for determining the velocities of raindrops has included the effect of the viscosity of the air and friction on the horizontal expanse of the drop. This formula is

$$v = 602.6\sqrt{r} + 57.013 - 23.291r^2,$$

where v is in cm. per sec., r in mm. and atmospheric pressure at 986.6 mb. (740 mm.). Applied to hail this formula becomes

$$v = 20.795(\sqrt{722.2r + 1/r^2} - 1/r).$$

The velocities of raindrops of the radii indicated are roughly as follows:

r 0.5 mm., v 400 cm. per sec.
r 1.0 mm., v 600 cm. per sec.
r 1.5 mm., v 700 cm. per sec.
r 2.7 mm., v 800 cm. per sec. (maximum).

Large drops are retarded by flattening in the air. According to Wiesner's observations this flattening of falling drops will cause those of 3.6 mm. radius to form rings and split into smaller drops.

NOTES

THE June number of the *Monthly Weather Review*, which appeared early in October, has more than 100 pages (quarto), which are devoted mostly to meteorological articles. The

[6] *Meteorologische Zeitschrift*, July, 1914, pp. 339–347.

amount and quality of the meteorological material published in the first six numbers amply justifies the change of this periodical back to its position as the national meteorological magazine.

The daily weather maps of the northern hemisphere issued by the Weather Bureau were discontinued on August 6 on account of lack of European weather reports.

The European meteorological magazines are still being received regularly, although late.

"The Clouds of California," an address by Dr. Ford A. Carpenter before the Occidental College, has been published.[7] The discussion concerns not only the cloudiness of California, but also includes information about the composition and formation of clouds.

W. Bieber[8] has introduced a new factor to explain the blue of the sky. According to him, the action of ultraviolet light forms $NH_4NO_2 + H_2O$, a thin bluish fog in the stratosphere. The blue of the sky is also ascribed to the action on light of dust particles, exceedingly small, snow crystals, air molecules, water vapor and ozone. Recent observations on high mountains show the presence of sufficient ozone alone to account for the sky color.[9]

In Symons's *Meteorological Magazine* for several months there has been a discussion of unusual visibility of distant objects as a prognostic of rain. Haziness is due to the amount and visibility of the dust and other particles in the air and to optical disturbances caused principally by temperature differences. So the cloudiness usually preceding rain reduces dust haziness by cutting off the bright illumination of the particles, and reduces the optical haze by preventing the unequal heating of the lower air and the establishment of convectional currents. However, wind blowing from the direction of a city, which may be even far away, generally makes the air more hazy.[10]

"British Rainfall, 1913" contains rainfall returns from 5,370 stations during the year. Complete daily records were received from 3,370 stations and less complete daily returns from 364 others. For the stations sending these daily records, the density for the British Isles is roughly 42 per 1,000 square miles. The January, 1914, issue of *Climatological Data for the United States by Sections* includes daily rainfall records from 4,391 stations. Thus for the United States, as a whole, the number of rainfall stations is but 1.4 per 1,000 square miles. Even Rhode Island, the state with greatest density of rainfall stations, has but 8 per 1,000 square miles. Nevada has 0.6 for the same area. It is little wonder that the climatic maps of the United States are lacking in detail as compared with the British ones.

Charles F. Brooks
Bureau of Plant Industry,
Washington, D. C.,
October 26, 1914

SPECIAL ARTICLES

SOME PHYSICAL PROPERTIES OF THE CELL NUCLEUS

Investigations on the physical properties of protoplasm have received fresh impetus through the introduction by Kite[1] of Barber's pipette holder for dissection purposes. By means of fine glass needles manipulated in this holder it is possible to undertake the dissection of fresh tissue under the highest magnification of the microscope.

My results in cell dissection largely substantiate Kite's general statements on the consistency and physical make-up of protoplasm.

In this paper I wish to present the results of studies made on the nucleus of the male germ cells of the grasshopper, *Disosteira Carolina*,

[7] 18 pages. See *Nature*, London, August 6, 1914, p. 592.

[8] *Meteorologische Zeitschrift*, July, 1914, pp. 358–359.

[9] See *Scientific American Supplement*, September 19, 1914, p. 179.

[10] See *Nature*, London, August 6, 1914, p. 592.

[1] G. L. Kite and Robert Chambers, Jr., "Vital Staining of Chromosomes and the Function and Structure of the Nucleus," Science, N. S., XXXVI., p. 639, 1912; G. L. Kite, "Studies on the Physical Properties of Protoplasm," *Am. Jour. Phys.*, XXXII., p. 146, 1913.

and of the cockroach, *Periplaneta Americana*. The follicles of the testis are isolated under the dissecting microscope and, on tearing the follicular envelope, the cells are set free. A good medium appears to be diluted Ringer's fluid to which has been added a trace of egg albumin. For the cells of the cockroach I used the body fluid collected by means of a capillary pipette. As the cells are very susceptible to mechanical stimulation care is necessary in these preliminary manipulations.

An uninjured, normal, isolated spermatocyte when not in division assumes a spherical shape. The nucleus occupies the center of the cell and, during the growth period, appears almost perfectly hyaline. In *Disosteira* three bodies stand out in the nucleus, their indices of refraction being different from that of the surrounding medium. One of them is rather elongated and lies immediately under the nuclear membrane. The other two are more or less globular and frequently lie well within the substance of the nucleus. In the cockroach only one such body or nucleolus is apparent.

Occasionally nuclei are met with in which may be discerned a mass of hazy filaments of very ill-defined outlines. It is possible that these are nuclei which have been unduly stimulated in teasing the tissue. Other nuclei are also discernible in which hazy bodies, the prophase chromosomes, are to be recognized scattered throughout the substance of the nucleus. In cells undergoing division the chromosomes are plainly visible during the meta- and anaphases.

Injury and frequently mere mechanical agitation of the cell produces a remarkable change in the appearance of the nucleus. The hitherto optically structureless nucleus begins to give evidence of hazy filament of a loose granular aspect. They lie immediately under the nuclear membrane and one gains the impression that they are produced by a lineal condensation or precipitation of granules in the hyaline nuclear substance. Within a few minutes the filaments become more distinct and thicken as the granules appear closer together. Free ends are soon to be noticed and one may occasionally trace a filament from one end to the other throughout its irregular winding course. They can not, however, be counted because they are hopelessly entangled. A light line down the middle of the filaments gives them the appearance of being longitudinally split. The granules are collected in bunches all along the length of the filament, giving it a cross striated effect. In those filaments which can be seen on end the granules are found to be arranged more or less regularly about a hyaline core. Such a structure may explain the longitudinally split appearance of the filament when viewed on the side.

The nuclear substance is a more solid and viscous gel than the cytoplasm. The filaments are still more solid and may be caught in the middle with a needle and drawn out into an attenuated loop fully as long as the diameter of the nucleus. On being set free the filament tends to retract and to thicken again. After the nuclei under observation have reached this stage the filaments collect on one side of the nucleus, and despite all my attempts to prevent it, coalesce into an irregular gelatinous mass.

The above changes take place in a period of five minutes to half an hour. Tearing of the cytoplasm of the cell accelerates the process and my conclusion is that the greater the amount of injury the more rapidly do the filaments form. In many cases the tearing causes the cytoplasm to absorb water and to go into solution. In the nuclei of cells so treated the formation of filaments takes place very rapidly.

The cells may be similarly stimulated by exposure to ether vapor. The nuclear filaments and the chromosomes then stand out clearly. Formalin vapor, on the other hand, seems to kill the cells without bringing into evidence the nuclear structure.

The stimulus produced by injury may be transmitted from the injured cell to a sound one if there be a cytoplasmic connection between the two. This is to be seen on piercing one of the daughter cells in the very late telophase of the spermatocyte. Near the end of

this stage the two daughter cells are connected with one another only by a narrow bridge of cytoplasm. Injury to the one causes the appearance of filaments in the nuclei of both. The changes in the nucleus of the cell directly injured take place more rapidly than do those in the nucleus of the other cell.

The formation or coming into evidence of the filaments is always accompanied by a slight increase in the size of the nucleus. After the filaments are formed the nucleus decreases in size often to something less than its original size.

The filamentous structure can be easily destroyed. For example, on sucking the entire nucleus containing filaments and nucleoli into a capillary pipette the bore of which is many times smaller than the diameter of the nucleus and on blowing it out again the nucleus presents itself as a homogeneous, glutinous mass with no structural elements whatever.

Frequently one comes across a cell the mechanical stimulation of which causes the appearance in the nucleus of ill-defined granular condensations which rapidly resolve themselves into the early prophase chromosomes familiar to investigators in fixed material, viz., crosses, rings and double V's. The ragged outlines characteristic of this stage are very pronounced and are due to the irregular granular aspect of the chromosomes. Gradually as one watches them the chromosomes become more and more compact. This appears to be due to an increase in the number of the granules and their coalescence. The large slender rings have thus been observed to transform themselves into ringlike, compact and homogeneous metaphase chromosomes. The crosses also become compact without losing their cross-like appearance. The same is true of the double V. One of these was observed which shortened and became so compact as to appear like a tetrahedron of which two opposite sides were somewhat more deeply dug out than the others.

This artificially induced formation of the chromosomes is unaccompanied by the dissolution of the nuclear membrane. The chromosomes soon clump together and become indistinguishable in an irregular glutinous mass. They are extremely viscous and adhere to the needle when touched. If one of the early prophase chromosomes with ragged granular outlines be seized by the needle and rapidly pulled across the field so as to stretch it the granules disappear and the whole substance becomes homogeneous. The entire nuclear substance is very glutinous and the chromosomes can not be taken out of the nucleus entirely free of the medium in which they lie. When torn out of the cell, however, in Ringer's fluid, the nuclear substance very soon absorbs water, swells and gradually disappears. The chromosomes thus laid bare in their turn swell and go into solution.

The chromosomes in metaphase are plainly visible. Movements while in the equator have been observed, these are ameboid, consisting in a swelling of one part of the chromosomes at the expense of another. One arm of a cross, for instance, will swell until the cross shape is indistinguishable and in another few seconds the swelling will decrease, the chromosomes returning to their original shape. I was unable to observe actual splitting of the chromosomes, but anaphase figures passing into telophase were frequently observed. The chromosomes collect at the poles of the spindle. They then swell into vesicles which appear to merge into each other much as fluid droplets, except that here incomplete outlines of the vesicles persist for a time giving the telophase nucleus an ill-defined network appearance.

During metaphase and anaphase the chromosomes lie imbedded in a hyaline substance the viscosity of which is higher than that of the surrounding cytoplasm, much resembling the matrix of the resting nucleus. This kinoplasmic mass retains its shape for a time after the cytoplasm has been destroyed by tearing and it is this that gives the characteristic spindle shape of the metaphase and hour-glass shape of the late anaphase figures.

When once the chromosomes have separated in metaphase, no interference short of total destruction of the cell will prevent the passage of the daughter chromosomes to their respective poles. By piercing and tearing the cytoplasm in the equator of the anaphase figure,

the constriction in that region may be so inhibited as to cause the two daughter cells to reunite into one spherical cell but the daughter nuclei remain separate.

As this paper is concerned only with intranuclear structures I shall merely mention here that the mitochondrial threads characteristic of the orthopteran germ cell form the boundary of the kinoplasmic mass and give it an appearance of being composed of threads. I have been unable to ascertain the existence of spindle fibers. The chromosomes may easily be pulled out of the equatorial plate and give no evidence of being attached to such fibers. When one chromosome is dislodged from the equatorial plate the others leave their places, and if left to themselves, clump together into an irregular homogeneous mass.

A curious phenomenon connected with the dissolution of the cells is the production of long slender processes which radiate in every direction from the surface of the cells. The ends of the processes soon grow into rounded knobs which gradually increase in size and often break off in the form of droplets. These droplets rapidly go into solution. Within half an hour or so, however, the entire protoplasm of the cell takes up water and swells. The pseudopodia are then slowly retracted and the cell rounds up and may remain so for a long time.

During the first stages of their formation the pseudopodia occasionally perform irregular oscillatory movements. Their formation is similar to that of sea-urchin eggs when subjected to the cytolytic action of diluted KCl solution. Similar phenomena have been described by Kite[2] and Oliver[3] and Merk[4] in blood cells. Chromosomes show the same phenomenon when isolated in Ringer's fluid. In one case which was very striking a ring chromosome was removed from the equatorial plate. Within two minutes a pseudopod began to appear from one side of the ring. Within five minutes this had lengthened into an attenuated filament which oscillated slowly. The attenuated tip gradually resolved itself into a knob which soon was pinched off in the form of a droplet. By the time a second droplet was formed and pinched off the chromosome itself began to swell and rapidly went into solution.

According to the foregoing experiments the chromosome appears to be a highly viscous and glutinous protoplasmic gel readily swelling in water and possessing very much the same physical properties as the cytoplasm of the cell.

Robert Chambers, Jr.

University of Cincinnati,
October, 1914

[2] G. L. Kite, "Some Structural Transformations of the Bloodcells of Vertebrates," *J. Inf. Diseases*, XV., p. 319, 1914.

[3] Science, N. S., XL., p. 645, 1914.

[4] *Arch. f. Mikr. Anat.*, 80, 1912.

THE GEOLOGIC HISTORY OF LAKE LAHONTAN

The basin of the great lake that once covered much of western Nevada has been classic ground ever since the early geologists first studied it. The shore lines which are to-day practically as the receding waters left them, the calcareous deposits about its basin, the possibility of saline deposits of commercial importance, have made the deciphering of its history one of the goals of geologic endeavor. King,[1] believing all of the tufa was a pseudomorph after gay-lussite and witnessing the formation of the latter in the Soda Lakes, believed that Lahontan had become as saline through desiccation, had then fallen, depositing the tufa as gay-lussite, and that a second flooding of the lake had caused it to overflow, washing out the saline material and changing the tufa to calcite.

Russell[2] determined that Lahontan had never had an outlet and thereby vitiated King's hypothesis. Believing that the tufas were a deposit from waters saturated with calcium carbonate and taking his clue from the Great Salt Lake, Russell assumed that the waters of Lake Lahontan must have been equally saline, although much of his evidence

[1] King, Clarence, U. S. Geol. Expl. of the 40th Par., Vol. 1, p. 522.

[2] Russell, I. C., Monograph No. 11, U. S. Geological Survey, 1885.

indicated otherwise. Finding the lakes at present occupying portions of the basin to be comparatively fresh, he believed that Lahontan had been completely desiccated and its saline deposits buried before the present lakes formed.

Russell recognized three types of the tufa in the Lahontan Basin; the lithoid, stony and compact; the dendritic, porous and coralline; and the thinolite, crystallized and a pseudomorph after an unknown mineral. For a distance of one hundred feet above the present level of Pyramid Lake these were found to be superimposed, the lithoid at the base, succeeded by the thinolite, and the dendritic covering the other two. While he recognized that there was some lithoid tufa intermingled with the dendritic, he believed that the lithoid had been deposited from waters of slightly different composition from those forming the dendritic tufa. Finding a medial series of gravels in the lake sediments, he believed that Lahontan had formed, diminished through desiccation and deposited the lithoid tufa, had again risen nearly to its former level, had again been desiccated, depositing the thinolite and dendritic tufas and, completely disappearing, left the other salts to be buried beneath the alluvium that swept in from the surrounding mountains. Later a slight change to a more humid climate produced the present lakes.

In the course of work in the vicinity of the Salton Sea,[3] done in connection with Dr. D. T. MacDougal, director of the desert laboratory of the Carnegie Institution of Washington, it was concluded that the tufa at present forming in the sea were being deposited through the activities of blue-green algæ and the bacteria associated with them. The more significant evidence discovered was the constant association of the algæ and the tufa, the extreme localization of the tufas, the formation of the tufa from water that contained considerably less calcium carbonate than would saturate it, and the evident relation between the development of the tufa and the light exposure. Further, a gradual gradation between the dendritic and the lithoid tufas was found in the older tufas of the basin, the lithoid tufa being formed in the dark portions of recesses in the cliffs where the conditions were unfavorable for the normal growth of the algæ. Thin sections of the older tufa show abundant remains of the algæ included in the tufa as are the algæ in the tufa forming at present.

Through the kindness of Dr. MacDougal it was possible to immediately carry the study in to the Lahontan Basin. Around the shores of Pyramid Lake a thin coating of lithoid tufa was found coating the rocks and in places cementing the gravels. The same close association between the algæ and the tufa was observed, and wherever the algæ were found the gravels were cemented and where they were absent no trace of the tufa could be found. Thin sections of the older dendritic tufa disclosed forms similar to those found in the tufas of the Salton Basin and sections of the tufa forming at present showed the algæ imbedded in it. As analyses of the lake water showed it to contain only about one twentieth the calcium carbonate necessary to saturate it, it is evident that the tufa forming to-day is being deposited through the activities of the plant life. As the algæ in the Salton Sea are depositing dendritic tufa from waters containing ten times more calcium carbonate than Pyramid Lake and the tufa being deposited in the latter at present is lithoid in type, it is probable that the calcium content of the lake waters is a determining factor in the type formed.

In the Lahontan Basin a thin layer of the lithoid tufa is in immediate contact with the rocks on which deposits of tufa were formed. Approximately six inches in thickness near the water's edge it decreases in thickness until at the top it merges with the caliche formed on the basalt that is the predominant rock in the basin, and it is practically impossible to say just where the tufa ends and the caliche begins. The dendritic tufa is best developed in a horizontal zone between one and two hundred feet above the present lake. It gradually diminishes in thickness and changes character

[3] Jones, J. C., Pub. No. 193, Carnegie Inst. of Wash., pp. 79–83, 1914.

until at the higher levels it merges with the lithoid tufa. In other words, the gradation between the lithoid and dendritic types in the Lahontan basin is a vertical one and was apparently caused by the increasing calcium carbonate content of the receding lake waters.

Russell placed the upper limit of the thinolite tufa at the thinolite terrace now one hundred feet above the lake. During the present study it was found that the thinolite extended some forty feet above the terrace throughout the Pyramid Basin and there ended in a few scattered crystals at the base of the dendritic tufa. Dana[4] after a careful study of the thinolite crystals came to the conclusion that it was a pseudomorph after an unknown tetragonal mineral, possibly a chlor-carbonate of calcium. Measurements by the writer of some of the more perfect crystals lead to the conclusion that the original mineral was orthorhombic and probably aragonite. On experimentation it was found that when a saturated solution of calcium carbonate was added to the water from Pyramid Lake minute crystals of aragonite closely resembling in their detail the smaller crystals of the thinolite separated after standing a day or two. The thinolite, therefore, was deposited as aragonite at a time when the waters of Lahontan were saturated with calcium carbonate.

As was recognized by Russell, the intermediary gravels are bar and beach deposits, and as only the lithoid tufa is associated with them they represent a low water stage in the filling of the basin.

To sum up the present evidence the broader features of the history of Lake Lahontan are believed to be as follows. As the Lahontan Basin began to fill the waters approximated those in the present rivers flowing into it and contained but little calcium carbonate. As a consequence the algæ as they became established on the rocks about the lake were able to deposit only the lithoid tufa. With the climax of the lake when evaporation became the controlling factor and the lake diminished the relative amount of calcium carbonate present increased more rapidly than the algæ could remove it. With the increasing amount of calcium available the type of tufa deposited gradually changed to the dendritic. Nevertheless, the calcium continued to increase until when the lake had fallen three hundred and fifty feet from its highest level, the waters were saturated and the surplus was deposited as aragonite forming the thinolite tufa. With the removal of the surplus calcium and probably aided by the slower fall of the lakes, owing to the diminished area the algæ caught up and have removed the calcium faster than it was brought in by the rivers until at the present time the lake contains only one twentieth the amount of calcium possible and only the lithoid tufa is being deposited.

As there is little or no evidence of an unconformity in the tufas, they in themselves do not indicate more than one lake period. The intermediary gravels are all above the present level of the lakes and from such evidence as has been gathered represent but a low water stage in the early filling of the lake basin. With the conclusion that Lake Lahontan had but a single period of extreme high water the question naturally arises as to whether the lake has completely disappeared.

One unfamiliar with the area and reading the reports of King and Russell is apt to gather the impression that a large part of the basin is covered by the tufa. This is not correct. As was noted by Russell, the tufa is extremely localized and occurs for the most part in large isolated masses. It is only the narrow band of recent tufa about the present shores of Pyramid Lake that approaches a continuous layer and it probably covers less than fifty per cent. of the shores exposed. A liberal estimate of the tufa-covered area of the basins of Pyramid and Winnemucca lakes is one per cent. of the total area of these basins and the tufa is much more abundant here than in the remainder of the Lahontan Basin. Estimating an average thickness of eight feet of tufa below the Thinolite terrace and three feet above it to the high-water mark gives sixty-five million tons of tufa deposited in the basins of the two lakes in question.

[4] Dana, E S., Bull. No. 12, U. S. Geol. Surv., 1884.

Assuming that the calcium has been brought into the Lahontan Basin in the same ratio to the sum of the sodium and potassium as it is being brought in by the present rivers and calculating how much calcium carbonate would have to be deposited to have maintained the same ratio to the sodium and potassium in the present lakes gives in round numbers one hundred million tons. As this figure is approximately the same as the amount of tufa deposited, it indicates that Pyramid Lake is a remnant of Lake Lahontan and that the latter has never been completely desiccated.

If this be true it is possible to approximate the age of Lake Lahontan by computing the number of years necessary for the Truckee River, the only important stream at present flowing into Pyramid and Winnemucca lakes, to carry into the lakes the amount of salt at present in solution. Several independent determinations were made, using the total solids, and such of the individual salts as were likely to have suffered little loss through deposition. Of these the chlorine gave the maximum figure, 4,500 years, while the others ranged from a thousand to 2,500 years. Unfortunately the Truckee flows also into Winnemucca Lake and there is some evidence that the latter may have been desiccated since the beginning of Lake Lahontan. Further, in times of high water Pyramid Lake has discharged into Winnemucca and it is uncertain how much saline material may have been lost by burial in the Winnemucca basin, if any. Judging from the correspondence between the actual amount of tufa deposited and the amount that should have been deposited, as indicated by the amount of salines still present in the lake waters, it is believed that the loss from this source has been slight.

A comparison of the total solids in the lakes to-day with those present at the time of Russell's visit when the lake was practically at the same level gives two thousand years as having elapsed since the basins first began to fill. From these concordant results it is probable that Lahontan first began to form within the last five thousand years.

There is abundant evidence of the comparative recent formation of the terraces, beach lines, and other shore phenomena of the ancient lake in their freshness and absence of erosion. Even where there is a considerable drainage basin behind them the terraces are barely notched by the streams that cross them and any one who is familiar with the erosive power of the not infrequent cloudbursts of Nevada can but wonder that the records of the old lake have stood so long without extensive defacement. Although faulting is still in progress, yet the shore lines and sediments of Lahontan have suffered little displacement. Careful measurements of the elevation of the terraces in different parts of the basin show them to still be horizontal.

Estimates go to show that if the rainfall of the drainage basin increased to somewhat less than double the present rainfall the Lahontan Basin would again fill to its former level. The recent work of Huntington[5] with the big trees of California indicates that there was such an increased rainfall in the immediate vicinity of the Lahontan Basin at the time it is believed the old lake was at its height.

While the work is still in progress yet it is so nearly finished that it is not believed that the above conclusions will be materially modified. The conclusion that Lahontan has never been completely desiccated and that the waters of Pyramid and Winnemucca lakes are residuals makes it possible to forecast the amounts of potassium deposits in the portions of the Basin that are at present desiccated. An estimate made for the Black Rock Desert indicated that if all the potash deposited from Lahontan were segregated in a single square mile it would form a deposit only three inches thick, and if potash beds are found in this desert they must have been formed in the buried sediments of a lake of which we have no knowledge at present.

J. Claude Jones

University of Nevada,
Reno, Nev.

[5] Huntington, Ellsworth, Rept. of Smithsonian Inst., for 1912, pp. 383–412, 1913.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and seventy-second regular meeting of the society was held at Columbia University on Saturday, October 31. The attendance at the morning and afternoon sessions included thirty-eight members. Vice-president L. P. Eisenhart occupied the chair. The Council announced the election of the following persons to membership in the Society: Dr. H. R. Kingston, University of Manitoba; Mr. Colin MacLennan, Havana Electric Railway, Light and Power Company; Mr. E. E. Moots, Walla Walla, Wash.; Mr. C. N. Reynolds, Jr., Harvard University; Dr. Joseph Rosenbaum, New Haven, Conn.; Dr. Joseph Slepian, Cornell University; Dr. Anna H. Tappan, Iowa State College; Dr. Mabel M. Young, Wellesley College. Several applications for membership were lost in the fire in the society's office; the secretary will be glad of any information regarding these. Four new applications were received.

A list of nominations of officers and other members of the council was prepared for the official ballot for the annual election in January. A committee was appointed to audit the treasurer's accounts for the current year. Arrangements were made for adjusting the insurance on the property of the society destroyed by the fire and for refitting the office with the most essential appliances.

The following papers were read at this meeting:

G. M. Green: "On completely integrable systems of homogeneous linear partial differential equations."

G. A. Pfeiffer: "Contributions to the conformal geometry of analytic arcs."

C. A. Fischer: "Conditions for a minimum of an n-fold integral."

Mr. E. C. Kemble: "Note on the definition of work."

H. S. White: "Census of the triad systems on 15 letters."

Edward Kasner: "A law of reciprocity in the calculus of variations."

K. P. Williams: "Concerning a certain totally discontinuous function."

T. H. Gronwall: "Some remarks on conformal representation."

The Southwestern Section of the society will meet at the University of Nebraska on November 28. The Chicago meeting of the society will be held on December 28–29, and the annual meeting in New York on January 1–2. At the annual meeting President E. B. Van Vleck will deliver his presidential address on "The rôle of the point set theory in geometry and dynamics."

F. N. COLE,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

AT a meeting of the American Philosophical Society held on November 6, Professor Eric Doolittle made a communication on "The Determination of the Longitude of the Flower Observatory of the University of Pennsylvania." This determination was effected by an employment of the wireless signals sent out by our government through the department of the Navy in their recent important international longitude campaign.

As is well known to astronomers, a long series of these wireless signals were interchanged on each night, from October, 1913, to March of the present year, between the powerful wireless station at Radio, Virginia, and the station at the Eiffel tower. The result of this work has, of course, not yet been reached definitively, but from the preliminary reductions it seems evident that the difference in longitude between these two widely separated stations will be determined with an accuracy which has never before been approached.

The process of determining the longitude of the Flower Observatory was described in detail by the lecturer, the very full directions sent by the Naval Observatory to the other observatories of our country having been closely followed in the work. The observations were continued from November 17 to December 20; the results of the 55 comparisons were in unexpectedly close agreement. The probable error of the final mean was but 0.015 sec., though it is probable that the effects of the personal equation have not been entirely eliminated from this result. The variation of the individual values was considerably less than that of those obtained three years ago by the ordinary telegraphic method, but the final value, as found, was about 0.1 sec. smaller than that found previously. It is evident, however, that the wireless method is one of extreme accuracy and probably the most accurate of all methods available.

The success of this work is due in no small degree to the continued courtesy and help of the officials of the Naval Observatory. From no account of wireless longitude determination, however brief, should there be omitted a word of appreciation of the work which they have now so nearly completed—a work excellently planned and ably executed, which is a contribution of enduring value to the science of exact astronomy.

THE NEW ORLEANS ACADEMY OF SCIENCES

The regular monthly meeting of the New Orleans Academy of Sciences was held in Stanley Thomas Hall, Tulane University, on Tuesday, October 20. President W. B. Gregory presided, with a large attendance of fellows and members. The president announced that during the summer a room had been furnished and equipped in the Stanley Thomas Hall for the library of the academy. The paper of the evening was read by Dr. C. C. Bass, professor of experimental medicine, on "Pyorrhea Alveolaris." The speaker said in part:

Pyorrhea alveolaris is almost a universal disease. It begins in childhood or early adult life in practically all people. It is usually unrecognized by the patient until one or more teeth get sore and loose in the socket. By a long suppurating process the peridental membrane, which holds the tooth in place, is destroyed, and the tooth is lost. This process goes on from year to year and tooth after tooth is lost, until finally all are removed by the disease or by necessary dental operation.

The cause of the disease has been found to be *ameba buccalis,* which destroys the peridental membrane, separating the tooth first from its gum and later the alveolar process or bony socket.

Emetine hydrochloride injected hypodermatically one half grain daily for three or four days, destroys the demonstrable amebæ in most cases and great improvement and cure of mild or early disease results. The treatment should be repeated one or more times in most cases, however, after an interval of one to four weeks. All patients and perhaps everybody should apply ipecac to their normal or diseased gums by brushing the teeth once a day with a wet brush on which one or two drops of fluid extract of ipecac are placed. The ipecac (from which emetine is made) should prevent the disease and apparently may cure it where not deep seated.

There was considerable discussion of the paper, in which Drs. Belden, Wallace, Wood, Mann and others took part. A unanimous vote of thanks was accorded the speaker at the end of his interesting paper.

R. S. Cocks,
Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 475th regular meeting of the society, held October 21 in the Public Library, Dr. D. S. Lamb, editor of the *Washington Medical Annals,* delivered an address on "Sanitation in Ancient Civilizations." The need of sanitation was especially shown by the histories of epidemics; for instance, the black death of the fourteenth century destroyed, it is said, about 25,000,000 persons. Pure water was one of the first necessities. Man must have availed himself at first of the use of springs, lakes and streams; later he dug wells and built cisterns, and still later built aqueducts. Old artesian wells are found in Asia Minor, Persia, China, Egypt, Algeria and even the Desert of Sahara. There were ancient aqueducts in Palestine, Greece, Mexico, Guatemala and Peru. Rome at one time had nineteen aqueducts, fourteen of which were large and had a total length of 359 miles. When the king of Persia traveled, he had the water boiled before drinking it. Among the Hebrews waste was buried or burned. The Romans built great sewers or cloacæ, several of which are still in use. At one time the sewers were cleaned out at a cost of a million dollars.

The dead, after battle, were usually buried in large pits or burned. To open such pits or church vaults and old burial grounds sometimes caused sickness and even death. The Egyptians embalmed the dead. Infants were often buried beneath the habitation. The dead were generally cremated in ancient Mexico, and in Rome from 450 B.C. until the spread of Christianity. In Greece the dead were buried near the houses of the living. Indian mounds in the United States contain the bodies of the dead. Hot-air baths and sweat baths were found among the ancients. Soap was mentioned by Pliny about A.D. 25 and was said to have been brought from Germany. The Hebrews were required by religious regulations to be clean in person, clothing and houses. The Romans had many public baths free to all. The Greeks bathed daily. The Hebrews attempted to segregate the lepers. Circumcision was common among the Egyptians and in many other parts of the world. Among the Hebrews it was a religious ceremonial. The Egyptians tabooed some articles of food, believing that diseases were contracted through them. The Hebrews had many rules of diet with the force of religious injunctions; especially as to meat, the animal was to be slaughtered in a certain way, with much attention to detail.

Daniel Folkmar,
Secretary

SCIENCE

Friday, December 11, 1914

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE OUTLOOK FOR SCIENCE[1]

The most remote origins of science are to be sought in the early observations of primitive races of men. At first phenomena were probably registered in memory with no attempt to relate them other than by means of the hypothesis that they were due to the will of some intelligence akin to that of man. It appears that an enormous period of time elapsed before men began to conceive even the possibility that these phenomena were bound together by laws through which they were capable of explanation. A long preparation of experience seems to have been necessary before this conception could arise.

But we are not to look back upon this period as barren. It gave rise to one thing at least of essential importance, namely, the effort to relate phenomena in such a way as to make the universe intelligible. It matters little what particular explanation was first offered; but it was a thing of profound importance to have conceived the possibility of any explanation at all.

The preliminary forms of this conception have probably been lost from the view of history. The first name which appears on the record as we now have it and indeed the first name in the history of European thought is that of the Greek philosopher Thales. He sought to go behind the great multiplicity of phenomena in the hope of finding a deep unity from which all difference had been evolved and by means of which these phenomena might themselves be explained.

It is interesting to note particularly that in this first attempt to make the universe intelligible Thales sought to ground everything in a single material cause. This he found in water. How he related it to the plurality of phenomena is not known. It is certain, how-

[1] An address delivered to the Indiana Chapter of the Society of Sigma Xi on November 5, 1914.

ever, that he set his contemporaries to thinking along a new line. Other explanations were offered each of which sought to find a basis for all phenomena in some one material substance. One of these was air. Another was a hypothetical substance having properties between those of air and fire. We need not mention more of these. It is sufficient to observe that it was hard to offer a reason why one of them afforded the desired explanation rather than another. One outcome, however, of this discussion among these thinkers is very interesting, namely, the conclusion reached by Anaxagoras that all things have existed in a sort of way from the beginning, but that originally they were in infinitesimally small fragments of themselves, endless in number and inextricably combined throughout the universe but devoid of arrangement. These fragments were the seeds of all things. The gradual adjustments of these among themselves have given rise to all phenomena whatsoever.

Thus ended the first search among the Greeks for a single material cause of all things. There followed a long period in which science no longer proposed to itself such an ambitious problem. In modern times each worker has been content to consider a narrow range of phenomena and seek a particular explanation. For a long time we have proceeded in this way with the study of special problems. In recent years we have been brought back in a most surprising manner to face the old problem of the Greeks. In the meantime our chemists and physicists had studied all known substances and had found that they were composed of about seventy elements.

When we had become thoroughly convinced that these elements were separate and distinct, radioactive substances made their appearance in our laboratories and we were compelled to revise our old opinions. Emanations of various sorts were then eagerly examined and before long it was realized that various of these seventy elements were giving off the same sort of electrons, so that they must certainly have something in common. Moreover, some elements were actually transformed into others.

In view of these facts one could hardly fail to raise the inquiry as to whether all elements are not indeed only different combinations of electrons. The speculative hypotheses of the old Greeks in the earliest period of scientific history thus stand prominently before our physicists in their laboratories to-day. The striking elements of agreement between a theory asserting that all matter is made up of electrons and that of Anaxagoras with its primal fragments of things are very remarkable, to say the least. What is done with this old problem in its new form will certainly exert a marked influence on scientific progress.

Looking from a certain point of view one may say that the great problem of science is to find out just what unities do exist among phenomena. If we can not trace everything to one cause we shall at least seek to find those general laws by means of which the greatest number of phenomena may be explained. This we must do in self-defense; otherwise we should soon be helpless before the enormous volume of science. Only if we grasp the great fundamentals, which include many particulars, shall we be able to continue our progress.

Economy of energy is one of the great demands which will press itself upon our attention with increasing force as the body of science is enlarged. One way to realize this economy is to make permanent conquests which remain for all time our possession. This is done in the science of mathematics. Other sciences should strive for the same permanence, but be all the time ready to grant that it has not been attained. No law of phenomena should ever be counted so well established as not to be subjected to every further test which ingenuity can devise. Over and over again our fundamental steps of progress have been taken in the most surprising way in fields of thought where everything had apparently been examined with the greatest care.

The way in which the mathematician has gained economy of energy through permanence of result is instructive. He confines his attention within limits so restricted that he may define his terms and ideas with the sharpest precision. In doing this it may be necessary to leave out of account a considerable part of

the problem in which he is interested. But the results which he obtains are permanent; these in turn he may use to arrive at tentative conclusions concerning the other parts of his problem.

In like manner it may be necessary that a theory in experimental science should restrict itself to a certain point of view in order to remain scientific. The range of phenomena, even in a restricted field, may be too great to be taken account of at once. Therefore some elements are left entirely out of mind until considerable progress has been made with the investigation. This was done in the case of the kinetic theory of gases, the size of the molecules being taken into consideration only after extensive investigations had been made in which this element was ignored.

Such a plan of procedure will cause us no uneasiness if we remember the guiding purpose of physical science. It does not attempt to afford us an explanation of the essence of things; if it did so it would find itself amidst inexplicable difficulty from the beginning. Its purpose, on the other hand, is to give direction to our researches into details and to afford us the best means of acting on things and of predicting phenomena.

It may very well happen that a "false" theory will serve this purpose better than a "true" one. In other words, a theory which is in agreement with only a narrow range of facts may be better for us at a given time than one which agrees with a much wider range. The one more nearly perfect, in the absolute sense, may be out of reach of our proper understanding or at least beyond any means of experimental verification at our command.

As a first example of this let us consider the case of a savage who has been accustomed to take the animistic view of nature. It may very well be true that his primitive theory brings helpful ideas and enables him to get around in his world and interpret it in a satisfactory way. His observations have little of precision about them and consequently they do not clash with his theory. To this creature the Newtonian law of gravitation would be meaningless and useless. For him it could serve none of the ends for which we employ that or any other scientific theory. For him to make such a hypothesis as this would be distinctly unscientific.

Another case in point is the old Greek theory of which we spoke a few moments ago. According to it all matter had a unique origin, and a primary task of the philosopher was to discover what substance gives rise to all others by the combination of its parts. None of the answers which they were able to arrive at, as we have seen, were of such character as to give them greater power to act on things or to predict phenomena. In accordance with a true scientific instinct the theory was therefore allowed to drop out of mind. Nowadays it has been revived in a different form because in this form it now seems capable of being subjected to experimental examination.

Probably the best example of the difficulties of a position where speculation has outrun observation is afforded by the atomic theory of the ancients, a theory which is very close in its general aspects to that which is usually accepted at the present day. In recent times this theory has given rise to the most important and far-reaching investigations. It has in a remarkable degree all the characteristics of a useful theory, which we enumerated above, and in many ways has proved itself vital in experimental investigations. Among the ancients, however, it seems to have led to nothing but speculations and disputings. It was too far in advance of other parts of scientific theory to be amenable to experimental investigation. Though essentially in agreement with facts, as we understand the matter to-day, it yet led to no scientific conquests in ancient times.

Such examples as these remind us that we should not set ourselves the task of finding the "true" explanation of things. From a scientific point of view our plans should be far less ambitious. This is a point, it seems to me, which we should be careful not to lose sight of. What we want to do is to frame general laws which to us appear to be the simplest we can find and which have the following three properties: they are in accord-

ance with all known phenomena; they enable us to predict events; they suggest to us new experimental investigations to carry out. We shall not undertake to say that these laws are true in any absolute sense. Furthermore, it will not cause us any uneasiness if we find a new phenomenon which contradicts one or more of them. That is a thing to be expected if we are making progress. It will be no surprise if a principle which was developed to relate past experiences should turn out to be insufficient to deal with future experiences.

The experimentalist is thus continually finding things which run counter to his preconceived opinions, whether they are based on unreasoned intuition or on large collections of facts. It is important to us to analyze the way in which men have heretofore met such situations. They will continually arise in our experience as long as we are making progress. From the most superficial examination we may see that they have often stood in the way of advancement.

When an opinion has gained a strong hold on our imagination it may obstinately refuse to be removed although it causes us grave trouble to keep it in agreement with facts or even leads us into contradictions from which we can find no escape. The early history of astronomy furnishes us with a good illustration of this matter. The Pythagoreans undertook to make precise the central problem of this science. Plato followed with other work along the same line. By means of a considerable range of speculation and reasoning, which would have little weight with us today and therefore need not be repeated now, these philosophers came to the conclusion that uniform motion in a circle is the most perfect of all motions, and therefore must be that of celestial bodies. But it was obvious that a simple motion of this kind for each of these bodies was insufficient to explain their positions at various times. Thus from the outset it was apparent that it would be necessary to consider the compounding of various circular motions in order to account for observed facts. Therefore those early thinkers confidently proposed as the fundamental inquiry of theoretical astronomy the following questions: How can we explain astronomical movements by means of uniform circular motions?

It was well to have this problem proposed, although it turned out to be incapable of solution. Directly or indirectly it has exerted a profound influence on the progress of every science. As long as the body of observation was sufficiently meager men could labor with some hope of answering the question as proposed. At first it was sufficient to compound two or three motions. After observations became more exact it was necessary to put together four or five circular motions for one body and to introduce numerous hypothetical spheres in order to have something to move along the requisite circular arcs. This thing continued till the explanations bewildered one with their complexity. Still men held to their preconceived idea of circular motion for many centuries until Kepler finally broke the spell by the discovery of the three laws on which modern theoretical astronomy is based. It is instructive to all scientific workers, I believe, to ponder the experience of men in dealing with this old problem.

As another example of the influence of preconceived opinion consider the old belief of chemists that the formation of organic compounds was conditioned by a so-called vital force. In accordance with this theory it should be impossible to synthesize organic compounds from dead matter. But in 1828 Wöhler succeeded with the synthesis of urea. But the belief in the necessity of a vital force died hard. Men tried to get around the new fact by supposing that urea stands midway between organic and inorganic substances. But the accumulation of other cases in which organic compounds had been synthesized finally led to the rejection of vital force as a factor in purely chemical relations.

A very curious case which was obviously in disagreement with facts is afforded by the old phlogiston theory of combustion. According to this theory combustibility is due to a principle called phlogiston, which is present in all combustible bodies in an amount proportional

to their degree of combustibility. The operation of burning was simply equivalent to the liberation of the phlogiston. This theory dominated chemical thought for more than a generation, notwithstanding its inherent defect due to the fact that the products of combustion were heavier than the original substance, whereas the theory demanded that they should be lighter.

I have purposely illustrated the influence of preconceived opinion by means of some of the older examples. Many others might be given. In fact, in nearly all our theories relative to experimental phenomena we introduce important elements not suggested by our observations, but by our own esthetic sense. Witness the introduction of the ether in so much of physical theory. A man sometimes feels that he is putting into his theory nothing except what observation has directed. This, I believe, is always a delusion. Moreover, I think that it is an undesirable thing to attempt. It is not true that observations compel any one theory. In fact, as Poincaré has shown, there is an infinite number of explanations of any finite set of facts. From among this enormous totality we must select the explanation which is most satisfying for us from considerations of convenience or from the demands of the esthetic sense. This is actually what we always do. It should be done consciously.

Now it is clear that any body of doctrine built up in this way is in danger of being seriously in error, and therefore it is necessary for us often to reexamine our theories with a view to ascertaining whether the preconceptions which were wrought into them still appear to be justifiable. This is one of the hardest tasks of the scientist. Accordingly he often waits long in the presence of his difficulties before he tries to overcome them by this heroic method. He is usually more averse to the surgical knife operating among his ideas than on the members of his body, however hard he may try to overcome this disposition.

It is no surprise that this is so. The race was too long practical before it sought to become scientific for us to make the change readily. Some one has defined the practical man as one who practises the errors of his forefathers. He is tied down to his preconceived opinions, not being enough of a dreamer to get away from them. He will be able to get through the world without receiving many hard knocks; but he will not inaugurate profound changes and advances in human life. That will always be left for the scientist who refuses to be satisfied with what is and who is always seeking a new sort of fact to destroy his own and his contemporaries' equilibrium.

But this will be harder for him to do as the years pass. In fact it is true in one respect that the problems of the scientist are increasing in difficulty. As the mass of accumulated observations grows larger there are fewer essentially new facts to be discovered. And when it becomes necessary to devise a new theory it is harder to make it fit into and explain the great array of recorded phenomena. But this affords no ground for pessimism, as we shall show in a moment. Moreover, it carries with it a reward of its own. If a theory can be made to fit into the facts as now known it has a good chance of doing service for some time, and this from the reason that it has been made to explain so many things already.

But there was a real advantage to be gained from the meagerness of data in the old time. It was not so difficult to theorize with some appearance of success, and therefore men the more readily conceived the possibility of relating things according to law and the more easily set up a tentative explanation. I have no doubt that speculative philosophy, for instance, has profited in times past by the meagerness of the data on which its speculations were based. The very fact that no large body of observed occurrences stood in the way of speculation emboldened men to launch forth upon what otherwise would have been a forbidding sea.

But confidence in setting forth did not save from danger and shipwreck. For some time we have known that no conclusion in science

is safe unless it is built up from a large collection of facts. Our philosophers are beginning to realize that the same sort of thing is true in their realm, and hence we should not be surprised to see science itself conquer a large part of the ancient domain of philosophy. Progress in this direction has already been sufficient for men to begin to speak definitely of "the scientific method in philosophy." Such indeed is the title of the volume containing the Lowell Lectures delivered by Bertrand Russell in Boston last spring. The adherents of this new method believe that it represents in philosophy "the same kind of advance as was introduced into physics by Galileo: the substitution of piecemeal, detailed and verifiable results for large untested generalities recommended only by a certain appeal to imagination." This method has gradually crept into philosophy through a critical scrutiny of mathematics. It is imbued with the essential spirit of a theoretical science based on experimental results.

The fact that the scientific method is encroaching upon the domain of philosophy will raise the question as to how far it is able to go towards solving the problems of metaphysics. It appears already to have been quite successful in dealing with the notions of continuity and infinity. But that it shall undertake to solve all the metaphysical problems is unlikely. What is more probable is that it shall pronounce many of them meaningless or else out of reach of exact investigation and consequently leave them to one side.

Returning now to the more special problems of science proper, let us inquire what is the present outlook for definite achievement in research. There are various types of answers to this question and various types of persons who make them. Some take an enthusiastically optimistic view of the situation. Others are pessimistic, though there seems to be less ground for pessimism now than there was fifteen or twenty years ago. Some of these pessimists believe that research is about to run out, at least in their own fields. They see nothing vital remaining to be done or else they feel helpless in the presence of a problem which is conceived. The persons who have this pessimistic feeling may be divided into two classes.

In the first place, there are those who have not attempted research and therefore have no first-hand acquaintance with its methods and problems and difficulties. At most they can see as through a glass darkly. One feels that their pessimism will prevent them from ever seeing as face to face. Some of these persons are so pronounced in their views as to believe that research has never made any really significant progress. They reach this opinion from quasi-philosophical considerations and not from an examination of the facts. It is unnecessary to refute these persons. Their judgment of matters of research properly has no weight at all among men who are actually engaged in extending the bounds of knowledge.

In the second place, our group of pessimists include those who have themselves undertaken research and have been unsuccessful in their venture. There is an obvious reason for their opinion; but it is one which makes no contribution toward answering the question as to the general outlook for definite achievement in research.

Over against these pessimists there is a large and ever-increasing body of enthusiastic researchers. They believe in to-morrow because they saw good things yesterday and have seen better ones to-day. It is hard for them to perceive how any one can fail to feel the expansion of growth in the midst of which he is living. To them it is the most natural of all expectations to think that we are just now on the eve of great developments. What is the ground of their confidence, insofar as it is not temperamental?

It is not that they have a vision of easy conquest. It can not be doubted for a moment that difficulties of the most serious sort confront us in scientific investigations. No one of these optimists can see the goal which he confidently expects science to attain. But there are some things which he can see, namely, past achievements and the circum-

stances under which the work has heretofore made progress.

It is the examination of these things which gives rise to such optimism, and especially of those of them which belong to the last few years. We shall not have time to take up these matters in detail so as to examine the events one by one; we can only indicate their general characteristics, leaving it to the reader to supply the concrete individual instances.

Let us ask: What is the leading characteristic, in the infancy of their development, of those processes and results of thought which have most profoundly influenced human progress?

To attempt a full discussion of this problem would carry us too far aside. But a partial answer lies close at hand. Great steps forward have usually been taken in a way which was not expected and in a field of mental activity where the processes and results of thought had assumed an apparently fixed form. In such a region there had been for a time a seething of thought with frequent eruption of new theory; but at last everything had come to a state of quiescence. Apparently, nothing more was to be expected from that quarter. But the appearance was false; a fresh development came with astonishing swiftness.

Often at a moment when least expected new and vital discoveries are made. Thought is ruthlessly jostled out of the rut into which it has fallen. A state of uncertainty and uneasiness ensues. Restlessly the mind seeks new verities to which to fix itself. There is a general shaking up of its content of thought. The old bottles are not strong enough for the new wine of new truth and are burst asunder. This quickening of thought, this expansion into larger conception, this is the leading characteristic of fundamental advances in human thinking.

This which I have just described is to my mind precisely the leading characteristic of several important theories of modern science. There has been a ruthless shaking up of the whole substructure; uncertainty, and even uneasiness, have arisen in many quarters; in some fields there is no longer any one who believes that he knows what should be expected. An eminent scientist who, a few years ago, was authority for the statement that the future advancement of physics was to be looked for in the fifth decimal place is now advising younger men to try all sorts of "fool experiments." This is an indication of the spirit of the times. We find indeed that our power over nature is increasing and that we can make better predictions than ever before; but we no longer have the faith which we once had in our theoretical explanations.

In recent years one surprise after another has come with such rapidity that we no longer know what it is to be orthodox in scientific theory.

A new liberty—some will say, a new license—in theorizing has sprung up everywhere. The boldness of some of the new hypotheses is amazing, even disconcerting. If ever they come into a general acceptance they will give rise to an expansive development of the human mind in virtue of our attempt to understand the philosophic significance of the new movements. They will require revision of our ways of thinking, and will thus mark a new stage in human progress.

An examination of the discoveries which have given rise to this sort of thing will lead to the observation that many of them were made in such unexpected ways that one almost feels as if they came about by accident. In fact there seems to be a certain element of haphazard in all scientific discoveries. We have not yet learned how to make a systematic and all-embracing search through fields of thought either old or new. Our best discoveries are frequently made in territory over which we have trodden many times before.

What are we to conclude from the fact that our particular discoveries are so often hit upon almost by chance and that we have looked about so nearly at random and have found such things? Let us answer by raising another question. Suppose that it had been true twenty years ago that only a few fundamental facts yet remained to be discov-

ered, in physics for instance, and suppose further that men had set about, as indeed they have, to try all sorts of "fool experiments"; then, in view of the infinite multiplicity of things which they might have tried, what is the probability that they would have discovered all or nearly all of the fundamentally new facts which twenty years ago were yet to be brought to light? According to the theory of probability, this chance is practically nil. Let us put with this result the further fact that for many hundred years men had been looking at phenomena with care and had not found the important facts discovered in this twenty-year period. Then, in view of all this we can only conclude that it is extremely probable that there is yet an unlimited, or at least a very great, number of fundamental facts still to be discovered. We can hardly refuse to draw the further conclusion that all we know at present is only a mere fragment of what we shall ultimately find out.

We can indicate the immediate prospect more precisely by a consideration of the present state of physics which I believe now stands in an enviable position with respect to all science and all philosophy—in fact, with respect to every body of doctrine whose development makes for human progress. In recent years it has undergone a marvelous rejuvenation, into the detail of which we can not now enter. It requires no eye of prophecy to see that this is certain to make itself felt in valuable advances in astronomy and geology and to lead the way to new and fundamental conquests in chemistry and biology. All branches of the sciences of phenomena should sit at the feet of the new physics in order to get in touch with her most recent discoveries and to carry them over to their consequences in other special domains of research.

All indications point to magnificent conquests of research in the immediate future and for many years to come. An analysis of the past gives us a strong assurance that there are many important things yet to be discovered. The progress of the preceding decade shows that we have in hand tools that have been effective, and we can hardly suppose that they have just now finished their work when we consider the sort of achievements which have just been made. Notwithstanding that the war in Europe will cut off many young men of enthusiasm and power and hinder the work of all investigators on that continent, it is yet true that there is an enthusiastic body of workers, especially in America, still carrying on their silent conquests which will take a place alongside the great achievements of the race. It is a pleasure to know that there is such an organization as this society to foster a work of this sort. I am glad that so many of us have entered upon the undertaking already and I hope that young men and women of promise will see a possibility of labor toward the good of the whole future of mankind and will lay their lives and their energies upon the altar of service in science.

R. D. Carmichael

THE PHILOSOPHY OF BIOLOGY: VITALISM VERSUS MECHANISM[1]

In comparison with mathematicians and physicists, biologists have contributed little to philosophical literature, notwithstanding the close relations existing between their science and philosophy. The most notable instance of recent years has been Driesch, whose attempts at philosophical commentary and interpretation seem, however, to have given on the whole little satisfaction to either biologists or philosophers. Bergson—"the biological philosopher," as Driesch calls him—bases much of his doctrine on biological data, and the use of such data appears to be becoming more frequent among philosophers. Lately professed biologists have shown somewhat more tendency to enter the field of philosophical discussion; and it is remarkable that when they do so they often adopt a vitalistic point of view. Haldane's "Mechanism, Life and Personality" is one recent illustration of this tendency, and the present book of Johnstone's is another.

[1] "The Philosophy of Biology," by James Johnstone, D.Sc., Cambridge University Press, 1914.

As the author himself explains, the point of view and methods of treatment are largely those suggested by Driesch and Bergson. The book is not long; there are eight chapters entitled, respectively, the Conceptual World, the Organism as a Mechanism, the Activities of the Organism, the Vital Impetus, the Individual and the Species, Transformism, the Meaning of Evolution, the Organic and the Inorganic; there is also an appendix with a brief account of the chief principles of energetics. In the table of contents is given a concise yet complete and connected summary of each chapter. This makes it unnecessary for the reviewer to summarize the whole book, and this review will be confined chiefly to a criticism of the author's main contentions and especially of the arguments by which he seeks to support his vitalistic thesis.

The first chapter discusses the relation of conceptual reasoning to reality. The author agrees with Bergson in regarding intellect as essentially a biological function, which reacts in a characteristic manner on the flux of reality and dissociates this more or less arbitrarily into detached elements; the aim of this dissociation is practical—namely, to facilitate definite or effective action on the part of the organism. Scientific method follows an essentially similar plan; our scientific descriptions and formulations of natural processes are conceptual schemata; their correspondence with real nature is inevitably inexact; they necessarily simplify and diagrammatize. In reality, however, nature can not be regarded as a composite of separate processes, individually susceptible of exact description in intellectual terms, and interconnected in ways which are similarly definite and quantitatively determinable; it is rather a continuous or flux-like unitary activity, exhibiting a progressive and irreversible trend; hence actual duration is distinct from the conceptual time of physicists. Now the intellect, in making its characteristic conceptual transformation, neglects or ignores or even falsifies much of the essential character of reality. This is how it becomes possible to view the living organism as a mechanism: the physiologist substitutes for the real living organism the conception of a system of physico-chemical processes, conceived as interconnected in a definite way; by doing so he is enabled to view the organism as essentially a physico-chemical mechanism; but we must note that the conceptual elements out of which he builds up his scientific view of the organism inevitably determine the nature of this end-conception, which is physico-chemical or mechanistic only because his method does not permit him to regard the organism as anything but a summation or integration of the physico-chemical processes that form the elements of his synthesis. As a result, however, he really misses what is most distinctive of living beings, and reaches a point of view which is not only inadequate for scientific purposes—as shown by the failure of physico-chemical analysis in the case of many vital processes—but in its very nature far removed from the actuality itself.

This is the fundamental criticism which the author makes of the accepted scientific methods of investigating life-phenomena. In the remainder of his book he interprets the characteristics of the organism and of the evolutionary process from this general or Bergsonian point of view. He sees operative in life a distinctive agency, corresponding to the "élan vital" of Bergson or the entelechy of Driesch, which acts typically in a direction contrary to that characteristic of inorganic processes; these latter tend toward homogeneity and dissipation of energy; in living organisms, on the contrary, evolution tends toward the production of diversity, and the tendency of entropy to strive toward a maximum may be compensated or even reversed by vital activity. "Life, when we regard it from the point of view of energetics, appears as a tendency which is opposed to that which we see to be characteristic of inorganic processes. . . . The effect of the movement which we call inorganic is toward the abolition of diversities, while that which we call life is toward the maintenance of diversities. They are movements which are opposite in their direction" (page 314). It is here that the author's views become most seriously open to scientific attack; the evidence

that the second law of thermodynamics does not always apply to life-processes is certainly inadequate; there is exact experimental evidence that the first law (that of conservation) holds for organisms; and the storing of solar energy by chlorophyll is in no sense evidence that the second law is evaded. There seems in fact to be a fundamental misconception in this part of the author's argument. He holds that life may play the part of the Maxwellian demon under appropriate circumstances (page 118), and defends this view on the ground that the laws of molecular physics are statistical in their nature and might be different if it were possible to control the movements of individual molecules; such control, it is implied, is possible to the vital entelechy. It seems to the reviewer, however, that the application of the second law to gases or solutions implies simply a tendency of the freely moving molecules to uniform distribution; the resulting homogeneity can be prevented only by adding energy to, or abstracting it from, part of the system; even Maxwell's demon has to work a partition which resists the impact of the faster molecules—a consideration which shows that any coordination or sorting of molecules would in itself involve the performance of work. Johnstone's supposition, however, is that the vital entelechy can, without altering the total energy of the system, control or direct the otherwise uncoordinated motions of the individual molecules; and that the purposive or directed character of the individual organism's life, and also of the whole organic or evolutionary process, is conditional on the existence of such an agency, and is indeed the characteristic expression of its activity. He thus maintains, in effect, that physiological processes are unintelligible unless we can assume the existence of some such directive agency peculiar to life, which can vary the nature, intensity and direction of the physico-chemical processes and coordinate them in the interest of the organism. This "entelechy" is what imparts their distinctive quality to life-phenomena.

It has long seemed to the reviewer that failures or deficiencies in the physiological analysis of complex or delicately adjusted functions form no sufficient ground for rejecting such methods of investigation as in their nature inadequate. Vitalists, however, are fond of this kind of attack; and both Haldane and Johnstone adduce instances which they believe make it incredible that physico-chemical processes, unguided by an entelechy, could ever form the basis of vitality. At present our knowledge of the physiology of embryonic development and of certain types of form-regulation is especially defective; and such phenomena are cited more frequently than any others as proving the inadequacy of physico-chemical analysis. Driesch's "logical proof of vitalism," quoted in the present book, is an instance of this tendency; even relatively simple processes like muscular contraction and nerve conduction remain largely mysterious, and we find also scepticism as to the possibility of any satisfactory account of these processes in physico-chemical terms (*cf.* page 100 of the present book).

A twofold reply to this type of vitalistic argument may be given. First, it is to be noted that the failure of physico-chemical analysis is often due to mere complexity of condition. But complexity, as such, does not introduce any essentially new problems; it simply makes more difficult, and may for a time make impossible, the task of analysis. Provided that the more elementary processes forming a complex process are characterized by *constancy* in their nature and in the conditions of their occurrence, any degree of complexity in the total process is possible. Ordinary experience with complex artificial systems, of a mechanical or other kind, verifies this contention; we find that there is no limit other than that set by practical expediency to the complexity of a system whose component parts operate and interact in a constant manner. In all such cases smaller and simpler parts are taken as units from which higher compound units are built up, and these secondary units are then similarly utilized for the construction of more complex systems; these may be still further combined, and so on. The one indispensable condition is that there should be an essential invariability in the operation

and interaction of the parts of the system. Similarly with life and its manifestations: the complexity of organisms and of organic processes, so far from making us despair of the adequacy of physico-chemical analysis in dealing with vital phenomena, seems in fact to the reviewer the surest witness to their essential adequacy. For these vital processes, however complex and mysterious, are unfailingly *constant* in their normal manifestation; one has only to reflect on what is continually happening in the body of a healthy man in order to realize this; and the stability of conditions thus shown surely has the same basis as have the stability and constancy of the simpler non-vital processes which we everywhere find as components of the vital. The basis of this stability is simply the exactitude with which natural processes repeat themselves under identical conditions.[2] If this were not the case, how could a physico-chemical system of the vast complexity of (*e. g.*) the human organism ever exhibit stable existence or constant action? It is impossible to doubt that the constancy with which complex physiological processes operate is conditional on the constancy of the simpler component processes—those which form the subject-matter of physico-chemical science. Constancy in the character, mode of action, and interconnection of the component substances and processes is evidently indispensable to the constancy or stability of the product of their integration, the living organism. We find in fact that mysterious and unintelligible physiological processes, *e. g.*, the regeneration of the lens in the eye of a salamander, recur under appropriate conditions with the same constancy as the simplest and most intelligible, say the formation of a retinal image by that same lens. It is clear that if we admit the adequacy of physico-chemical methods in the one case we must be prepared to do so in the other.

Second, it is to be noted that the organic processes show evidence by their very limitations that the underlying mechanisms are strictly physico-chemical in character. Thus vitalists call especial attention to the instances of development and form-regulation which have so far baffled all attempts at physico-chemical analysis. "Does not this mean," Johnstone asks, "that in biology we observe the working of factors which are not physico-chemical ones?" The limits to the regulative power are less frequently cited by vitalists; yet surely evidence of this kind is equally relevant. Why, if an entelechy can restore the amputated arm of a salamander, can not it perform a similar miracle in the case of a man? The fact is that nothing is proved by citing such cases. But on the whole they seem clearly to imply that the properties of the organism are throughout the properties of physico-chemical systems, differing from inorganic systems simply in their complexity. The reviewer knows of no facts which, viewed without prepossession, necessitate or even unequivocally favor the contrary view. Those vitalists who maintain that material systems are incapable, without the aid of an entelechy, of developing the characteristics of life—and who even hold that fundamental physical laws like the second principle of energetics are evaded by organisms—must adduce evidence of a less doubtful kind in support of their thesis. The peculiarities which organisms exhibit appear to the reviewer to lead to precisely the contrary conclusions, and to indicate that stable and constantly acting physico-chemical systems may exhibit a degree of complication, both of composition and of behavior, to which literally no limits can be assigned.

Another mode of reasoning popular among vitalists, and equally fallacious from the physico-chemical standpoint, is that an entelechy can, without the performance of work, guide or coordinate toward a definite end processes which themselves require the performance of work. This view implies that in the organism molecular movement may be directed, retarded, or accelerated at the will of the entelechy. But in Newton's first law of motion it is surely made clear that any deviation in the move-

[2] Just why there is such repetition is rather a philosophical than a scientific question; but it seems probable that it is at bottom an expression of the homogeneity of the conditions of natural existence, space and time.

ment of a particle from a straight line, or any retardation or acceleration of its motion, involves work in precisely the same sense as does the initiation of the movement. Now it is evident that guidance or regulation of the sequence of events in any material system must involve one or other of these kinds of processes. In other words, it is physically impossible for any agency to modify the processes in any material system without modifying the energy-transfers in that system, and this can be done only by the introduction of compensating or reinforcing factors of some kind—*i. e.,* by altering the energy-content of the system—which is equivalent to the performance of work. One is forced to conclude that all such attempts at the solution of biological problems are based on fundamental misunderstandings. Dogmatism must be avoided in scientific criticism; nevertheless it seems to the reviewer that the following general considerations are incontrovertible, and that they are quite inconsistent with the type of vitalism represented by Driesch and Johnstone. First, the organism is a system whose development and continued existence are *dependent* on the rigid constancy of physico-chemical modes of operation; here, if anywhere in nature, stability of the internal or vital conditions is indispensable; otherwise it is inconceivable that the complex living system could persist, and maintain its characteristic activities and often delicate adjustment to the surroundings. Clearly the numerous and diverse processes whose integration constitutes life could not deviate far from a definite norm without fatal derangement of the whole mechanism. Second, the basis for this regularity is the regularity of physico-chemical processes in general. These, the more closely they are subjected to scientific scrutiny, appear the more definite and constant in their character: this conclusion is not—as many philosophical critics of scientific method maintain—an illusion resulting from the inherently classificatory nature of intellectual operations; it is simply a matter of observation and experimental verification. Repeat the conditions of a phenomenon and the phenomenon recurs. We find this to be equally the case in living organisms and in non-living systems; and it appears to be as true of psychical as of physical phenomena. The difficulty in dealing with organisms is to secure exact repetition of conditions, because organisms are in their nature complex, and complexity means a large number of factors which may vary. Regularity, in fact, may be said to be of the very essence of vital processes; special devices for securing regularity (*e. g.,* constancy of body-temperature, of the osmotic pressure and reaction of the tissue-media, etc.) are highly characteristic of organisms. It would seem that an entelechy disturbing this regularity, however intelligently, would be not only superfluous but detrimental. Moreover, we must always remember that unequivocal evidence for the existence of such an agency is quite lacking.

Thus there seems to be no valid reason to believe that organisms differ essentially from non-living systems as regards the conditions under which the processes underlying vitality take place. The *conditions* of natural existence and happening appear everywhere and at all times to be homogeneous, whatever existence itself may be. This conclusion seems unavoidable to the impartial observer of natural processes; the repetition so characteristic of nature is apparently an expression of this central fact. The flux-like character of natural existence, so insisted upon by Bergson and the other Heracleiteans, is to be admitted only in a highly qualified sense. Repetition and the existence of discontinuities and abrupt transitions are equally characteristic; and all of the evidence of physical science goes to show that a repetitious or atomistic construction lies at the very basis of things. So far from the intellect arbitrarily imposing a diagrammatic uniformity and repetition upon a nature which in reality is a progressive flux and never repeats itself—to the student of natural science it appears rather true that the conceptualizing characteristic of the reasoning process is itself one expression of this fundamental mode of natural occurrence—that it is, in fact, the derivative of a peculiarity which pervades na-

ture throughout. Such a view, if well established, would refute the contention that scientific methods, being intellectual in their character, necessarily involve a falsification; and would dispose of attempts to discredit physiological analysis on the ground that life transcends intellect and hence is properly to be investigated by other than scientific methods.

The attempt to find in organisms evidence of special agencies not operative in the rest of nature seems to the reviewer to show less and less promise of success as physico-chemical and physiological science advances. Thus the author's attempt to limit the applicability of the second law of energetics to the non-living part of nature is quite unjustified by the evidence which he presents. The interception and accumulation of a portion of the radiant energy received by the green plant, in the form of chemical compounds of high potential, is in no sense an infringement of the second law; as well might one hold that the partial transformation of radiant energy into potential energy of position, as seen, *e. g.*, in the accumulation of glaciers, is an instance of this kind. The partial transformation of energy at low potential into energy at high potential is in fact a frequent occurrence; thus the temperature of an electric arc far exceeds that of the furnace which generates the current; similarly the animal organism utilizes energy derived from oxidation of carbohydrates and proteins to build up compounds of much higher chemical potential, viz., the fats. If living organisms—systems which are specially characterized by utilizing chemical energy as the main source of their activity—exhibit such tendencies, there is in this fact nothing anomalous from the point of view of physical science. To say on the basis of this kind of evidence that "life appears as a tendency which is opposed to that which we see to be characteristic of inorganic processes" (page 314) is surely unwarranted from any point of view.

This review is not necessarily an attack on vitalism, but only on certain current forms of vitalism. It can scarcely be denied that there is something distinctive about life; but at the present advanced stage of physical science it seems futile to argue that the vital process is the expression of an agency which is absent from non-living material systems. Viewed temporarily or historically, the vital is seen to develop out of the non-vital; many of the steps in this process are still obscure; but with the progress of science it becomes more and more evident that the development is continuous in character. Hence, if we are to account for life, we must equally account for non-living nature. Now since nature exhibits itself as coherent throughout, we must conclude that in its inception[3] it held latent or potential within itself the possibility of life. This is not entirely an unbased speculation; even in the character of the chemical elements life is foreshadowed in a sense, as shown in Henderson's recent interesting book.[4] In a recent discussion,[5] in some respects related to the present, the reviewer has called attention to one implication of the scientific view of nature and the cosmic process. If we assume constancy of the elementary natural processes, and constancy in the modes of connection between them—as exact observation forces us to do—there seems no avoiding the conclusion that—given an undifferentiated universe at the outset—only one course of evolution can ever have been possible. Laplace long ago perceived this consequence of the mechanistic view of nature, and the inevitability of his conclusion has never been seriously disputed by scientific men. Nevertheless, this is a very strange result, and to many has seemed a *reductio ad absurdum* of the scientific view as applied to the whole of nature. The dilemma can be avoided only if we recognize that the question of ultimate origins is not, strictly speaking, a scientific question at all; and in saying this there is implied no disparagement of scientific method. As an object of scientific investigation nature has to

[3] I do not use this term necessarily in a historical sense, but rather in the sense of ultimate origin of whatever kind,—which it may well be necessary to conceive as extra-temporal.

[4] "The Fitness of the Environment," Macmillans, 1913.

[5] Science, N. S., 1913, page 337.

be accepted as we find it; and why it exhibits certain apparently innate potentialities and modes of action which have caused it to evolve in a certain way is a question which really lies beyond the sphere of natural science. Such considerations, if they do not exactly remove the vitalistic dilemma, yet separate sharply the scientific problems which organisms present from the metaphysical questions to which the phenomena of life—more than any others —give rise. If we consider the organism simply as a system forming a part of external nature, we find no evidence that it possesses properties that may not eventually be satisfactorily analyzed by the methods of physicochemical science; but we admit also that those peculiarities of ultimate constitution which have in the course of evolution led to the appearance of living beings in nature are such that we can not well deny the possibility or even legitimacy of applying a vitalistic or biocentric conception to the cosmic process considered as a whole.

Although disagreeing with the author's main contentions, the reviewer wishes to recognize the merits of the book as an interesting, enthusiastic and ingenious contribution to the literature of its subject. We have noted some errors in matters of biological detail, but these are not such as to affect the main argument. The brief account of certain physiological processes seems somewhat out of date; the account of the nerve impulse is unsatisfactory, and certainly few physiologists now hold that a muscle is a thermodynamic machine in the sense conceived by Engelmann; there is some evidence of unfamiliarity with biochemistry; the term "animo-acid" instead of amino-acid recurs a number of times, a mis-spelling perhaps appropriate to a book which is really a modern plea for animism.

RALPH S. LILLIE

CLARK UNIVERSITY,
October 12, 1914

THE COMMITTEE OF ONE HUNDRED ON SCIENTIFIC RESEARCH

ON the invitation of the chairman of the executive committee of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science, there was held at his house on the evening of November 28 a meeting of the executive committee and of some members of the subcommittees and of the general committee resident in or near Boston. There were present Mr. Charles W. Eliot, president of the association and chairman of the committee, Mr. E. C. Pickering, chairman of the executive committee, and Messrs. E. W. Brown, J. McKeen Cattell, W. T. Councilman, Charles R. Cross, Reid Hunt, Richard C. Maclaurin, A. A. Noyes, Theodore W. Richards, Elihu Thomson and Arthur G. Webster.

Plans for the work of the committee were discussed, and preliminary reports were presented from four of the subcommittees, as follows: Research funds, by Mr. Cross; research work in educational institutions, by Mr. Cattell; the selection and training of students for research, by Mr. Brown, and improved opportunities for research, by Mr. Richards.

In addition to the subcommittees whose membership has been announced, the committee on improved opportunities for research has been completed, and consists of Messrs. Theodore W. Richards, chairman, W. T. Councilman, Richard C. Maclaurin, T. H. Morgan and E. H. Moore. The subcommittee on the selection and training of students for research has also been formed, and consists of Messrs. E. W. Brown, chairman, Ross K. Harrison, George A. Hulett and W. Lindgren. Subcommittees have been authorized on research institutions, research in industrial laboratories, research under the national government, research on the Pacific coast and research in the south, but these committees have not yet been completely organized.

Reports from subcommittees will be presented at the meeting of the Committee of One Hundred, which will be held in the Houston Club, University of Pennsylvania, Philadelphia, at 2 o'clock, on the afternoon of December 28.

J. MCKEEN CATTELL,
Secretary

THE PHILADELPHIA MEETING

THE local committee for the Philadelphia meeting of the American Association make the following announcements:

The hotels are either near the center of the city or in close proximity to the University of Pennsylvania. The headquarters of the association will be the Hotel Adelphia, 13th and Chestnut Streets, two blocks distant from both the Pennsylvania and Philadelphia & Reading Railroads. The Adelphia is the newest and most modern hotel in Philadelphia. Members are urged to make hotel reservations as early as possible.

The meetings of the association will be held at the University of Pennsylvania in West Philadelphia, ten minutes by trolley from the center of the city. The university can be reached by taking cars, route 13, on Walnut Street, one block south of the association headquarters, or cars route 11 or 34 on the subway surface lines on Market Street, one block north. Persons arriving on the Pennsylvania Railroad and desiring to go directly to the University of Pennsylvania or to hotels near the university should get off at West Philadelphia Station, six minutes' walk to the university.

The Houston Club, Spruce Street near 34th Street, has been designated as the association headquarters at the University of Pennsylvania. This building is the geographical center of the university and all meetings of the association will be held in university buildings within a radius of two blocks from this point. The privileges of the club are extended to all of the members of the association and affiliated societies. Mail may be addressed here.

The general meeting of the association will be held in Weightman Hall, gymnasium of the University of Pennsylvania, 33d and Spruce Streets, on Monday evening, December 28, at 8 o'clock.

Luncheon will be served in the gymnasium, daily at one o'clock, during the convention, and all in attendance are cordially invited.

The provost of the University of Pennsylvania will give a reception to the members of the association in the university museum immediately after the address of President Wilson.

Placards of the university campus will indicate meeting places of the various sections.

The Geological and Paleontological Society will hold its meeting at the Academy of Natural Sciences, 19th and Race Streets.

SCIENTIFIC NOTES AND NEWS

THE De Morgan medal of the London Mathematical Society was presented at its annual meeting to Sir Joseph Larmor in recognition of his researches in mathematical physics.

PROFESSOR H. F. NEWALL has been elected president of the Cambridge Philosophical Society. The vice-presidents are Dr. E. W. Barnes, Dr. A. C. Seward and Dr. A. E. Shipley.

PROFESSOR WILHELM ERB, the distinguished neurologist of Heidelberg, has celebrated the fiftieth anniversary of his doctorate.

PRESIDENT CHARLES RICHARD VAN HISE, of the University of Wisconsin, will be the convocation orator at the University of Chicago.

PROFESSOR ROBERT M. YERKES, who on the invitation of the authorities of the German Anthropoid Station at Orotava, Tenerife, had planned to spend the greater part of the year 1915 at the station in an experimental study of the chimpanzee and orang-outang, has been forced to abandon his plan because of the condition of war in Europe. He will instead conduct his investigations during the spring and summer of 1915 at Montecito, California, in conjunction with Dr. G. V. Hamilton, in the latter's private laboratory. From February to October, 1915, Professor Yerkes may be addressed at Santa Barbara, California.

PROFESSOR J. C. BOSE, of Calcutta, known for his work in plant physiology, is in this country. He is to be in the east until January 11, on which date he addresses the New York Academy of Sciences, and before which time he will speak at various universities and to scientific bodies. During the latter part of

January he is arranging a trip to several middle western universities.

Dr. Paul V. Neugebauer has been appointed observer in the astronomical institute of the University of Berlin in succession to Professor P. Lehmann.

The Harvard corporation has appointed Arthur W. Carpenter, of Boston, to the Central American fellowship in archeology, with an income of $600 a year.

The *Journal of the American Medical Association* states that the salaries of Dr. Haven Emerson, sanitary superintendent, and Dr. William H. Park, general director of laboratories in the New York Health Department, have been increased to $6,000 a year on the condition that they give their full time to the work, relinquishing private practise and their work in Columbia University.

Dr. Albert Calmette, the eminent pathologist, director of the Pasteur Institute at Lille, who has been acting as one of the chiefs of the medical service of the French army, has been missing for some time. It is now reported that he is a prisoner of war at Münster. Dr. Calmette is a brother of the late editor of the *Figaro,* Gaston Calmette.

Dr. F. F. Buckhemer, third incumbent of the exchange curatorship in paleontology at Columbia, is a prisoner of war in Brest, France, and Dr. Hülsenteck, fourth incumbent, is a prisoner of war in Gibraltar.

The Iron Cross has been awarded to Dr. Karl Thomas, of Professor Rubner's laboratory in Berlin, who was in charge of a field hospital near Mons, for courageous action during the retreat.

Dr. Felix von Luschan, director of the Berlin Museum of Ethnology and professor in the university, lectured before the Germanistic Society in New York on December 2, on "Peoples of West Asia," and at Columbia University on December 9 on "Excavations in Asia Minor."

Dr. Henry S. Graves, chief forester of the United States, lectured before the Washington Academy of Sciences on December 3, on "The Place of Forestry in the Natural Sciences."

Professor Lafayette B. Mendel, of Yale University, will give a course of lectures under the Herter foundation, at the University and Bellevue Hospital Medical College, on December 10, 11, 14 and 15. The subject of the lectures, which will be given at four o'clock in the afternoon, is "Aspects of the Physiology and Pathology of Growth."

Mr. P. Macleod Yearsley lectured upon the "Classification of the Deaf Child for Educational Purposes" at a meeting of the Child Study Society at the Royal Sanitary Institute, London, on November 5.

We learn from the *Cornell Alumni Weekly* of the death of Daniel Elmer Salmon, the first chief of the U. S. Bureau of Animal Industry, at Butte, Mont. He was born at Mount Olive, Morris county, N. J., in 1850, and entered Cornell University when it opened in 1868. He became interested in the study of veterinary medicine after becoming acquainted with Dr. James Law, who had just come to Cornell from Scotland. After practising for several years, Dr. Salmon was from 1878 till 1884 connected with the U. S. Department of Agriculture as an investigator of animal diseases. The Bureau of Animal Industry was established in 1884, and Dr. Salmon was appointed chief of that bureau, holding the office till 1906.

Dr. George L. Manning, professor of physics at Robert College in Constantinople, has died in Florence, Italy, while on his way home, after a recent illness. Dr. Manning was 50 years old. He was graduated from the Massachusetts Institute of Technology and had taught at Stevens Institute of Technology and at Cornell University.

The Reverend Dr. Addison Ballard, at one time professor of science and mathematics at Marietta College and Ohio University, and later professor of philosophy at Lafayette College and at New York University, has died at the age of ninety-two years.

DR. EWALD FLÜGEL, of the chair of English philology at Stanford University, died at his home in Palo Alto on the evening of November 14, in the fifty-first year of his age. He had been connected with the university from its beginning in 1892, coming from the University of Leipzig.

DR. GIOVAN BATTISTA GUCCIA, professor of higher mathematics in the University of Palermo, died in that city on October 29. Professor Guccia was the founder in 1884 of the Circolo Matematico di Palermo and editor of its *Rendiconti*.

DR. CHARLES BARRETT LOCKWOOD, a distinguished English surgeon, well known as a teacher and as a writer on surgery, has died at the age of fifty-six years from septicemia contracted in the course of an operation.

DR. HEINRICH BURKHARDT, professor of mathematics in the Technical Institute of Munich, has died at the age of fifty-three years.

DR. EMIL ALFRED WEBER, emeritus professor of philosophy at Strassburg, has died at the age of seventy-nine years.

LIEUT.-COLONEL SIR DAVIS PRAIN, director of the Kew Botanical Gardens, has lost his only son, Lieut. T. Prain, who has been killed in action.

DR. F. FELIX HAHN, assistant curator in the Königliche Hof Museum, Stuttgart, and lieutenant in the Bavarian artillery fell before Nancy on September 8. On receiving his doctorate from Munich in 1911, he came to the paleontological department of Columbia University as the first exchange assistant and curator in paleontology. During his year in this country he did some detailed work on the graphohtes leading to the publication of his paper "On the Dictyonema Fauna of Navy Island, New Brunswick." Another contribution was on "The Form of Salt Deposits." Among his papers in German may be mentioned: "Ergebnisse neuer Spezialforschungen in den Alpen," "Die neuere regional geologische Spezialliteratur der bayerischen und nordtiroler Alpen," "Zür Geologie der Berge des oberen Saalachtales," "E. O. Ulrichs 'Revision der Palaeozoischen Systeme'—ein Merkstein der Stratigraphie als Wissenschaft?," "Untermeerische Gleitungen bei Trenton Falls (Nord Amerika), und ihr Verhältniss zu Ahnlichen Störungsbildern." This last paper is one of the most important contributions to structural geology made in this country in the last few years.

THE Carnegie Museum has secured, through Professor C. H. Eigenmann, the pamphlet library of the late Dr. Albert Günther, long headkeeper of the British Museum of Natural History, justly regarded in his time as the most eminent ichthyologist and herpetologist of Great Britain. The collection comprises almost all the literature relating to fishes and reptiles printed in the periodicals and journals of learned societies during the eighteenth and nineteenth centuries.

THE Georgia State Sanitarium at Milledgeville has been selected by the United States government as a station for experimental work in pellagra cases. The patients will be segregated and kept under special treatment and diet, the work being done under the charge of two experts of the United States Public Health Service.

A SERIES of addresses on subjects connected with the European war is announced at the University of Chicago. They include: "Racial Traits Underlying the War," William I. Thomas, professor of sociology, December 3; "The Balkan Question," Ferdinand Schevill, professor of modern history, January 7; "Russian and Asiatic Issues Involved," Samuel N. Harper, assistant professor of Russian language and institutions, January 14; "The Effects of the War on Banking and Credit," Professor Andrew C. McLaughlin, February 4; "The Ethics of Nations," James Hayden Tufts, head of the department of philosophy, February 11; "The Rights and Duties of the United States as a Neutral Nation," Charles Cheney Hye, professor of law, Northwestern University, February 18; "Geographical and Economic Influences," J. Paul Goode, associate professor of geography, February 25;

"The Effects of the War on Economic Conditions," Chester W. Wright, associate professor of political economy, March 4.

THE Rice Institute announces its first series of unversity extension lectures to be given on the afternoons of Mondays, Wednesdays and Fridays. The scientific lectures, given on Wednesdays, are as follows:

Electricity, illustrated by numerous experiments, a course of six lectures by Harold Albert Wilson, professor of physics.

The Geology of Texas, a course of three lectures by Edwin Theodore Dumble, consulting geologist of the Southern Pacific Company.

Applications of Chemistry to Industry and Commerce, a course of three lectures by Arthur Romaine Hitch, instructor in chemistry.

As an answer to the impression which seems to exist, that all the public lands of any value have long ago been taken up, Secretary Lane, in an advance statement from his annual report, calls attention to the fact that since March 4, 1913, settlers have made entry on nearly 20,000,000 acres of public lands—an area equal to that of Connecticut, Massachusetts, New Hampshire and New Jersey combined. During the same period practically as much more coal and other mineral land of the west has been examined in detail in 40-acre tracts by the Geological Survey, and most of it has been thrown open to settlement or purchase. Some of these lands, such as those which include workable deposits of phosphate or oil, are still withdrawn pending suitable legislation for their disposal or use. Another important activity in public-land classification to which the secretary calls attention is the designation of lands for entry as "enlarged" or 320-acre homesteads. Designations under this law approved by him, cover 33,453,056 acres. The extract from the secretary's report contains a series of maps of twelve public-land states showing in graphic form (1) the areas withdrawn from entry in these states between March, 1913, and July, 1914, (2) the areas restored to entry, (3) the designations under the enlarged-homestead law, and (4) land taken up by settlers. Thus, for example, the map of Montana shows the total area for the state, 93,000,000 acres; lands withdrawn from entry, 67,741 acres; lands restored to entry after examination, 3,171,558 acres; lands designated under the enlarged-homestead law, 11,022,854; acres and lands entered by settlers, 7,417,291 acres. The other states in which public-land activities have been large and which are discussed by the secretary are Utah, Wyoming, Colorado, New Mexico, Idaho, Washington, Oregon, North Dakota, Arizona, California and Nevada.

ATTENTION is called by *The Observatory* to the fact that at the congress of the representatives of the national ephemerides held in Paris in 1911 a scheme of cooperation between the various countries was planned, so as to assure in the future a greater production of useful work and to avoid a superfluous repetition of the computations. This end was to be attained by a plan of exchange and division of work, although each Almanack was to retain its own distinctive features. The ephemerides for 1916 mark the inauguration of this arrangement. The Nautical Almanack Office has been supplied from abroad with the following: The ephemeris of Mercury from Berlin. The apparent places of polar stars from Paris. The apparent places of stars from Berlin, San Fernando and Turin. Details of eclipses and elements of occultations from Washington. The positions of the satellites of Mars and of Jupiter's fifth satellite from Washington; of Jupiter's four principal satellites from Paris; of Saturn's satellites and ring from Berlin; of the satellites of Uranus and Neptune from Washington. Physical ephemerides of the sun, moon, Mercury, Venus, Mars and Jupiter from Washington. The Nautical Almanack Office has in its turn supplied, under this arrangement, the greater part of the Greenwich ephemerides of the sun, moon and planets. In the table of the mean places of stars the magnitudes are taken from the Revised Harvard Photometry, instead of, as previously, from Newcomb's Fundamental Catalogue. The spectral types, as given in the Revised Harvard Photometry, are now also added. From 1916 onwards, the fundamental meridian adopted by the *Connaissance des Temps* will be the meridian of Greenwich.

THE annual meeting of the American Anthropological Association will be held in Philadelphia from December 28 to 31, in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society. Titles for the joint program should be sent immediately to Professor George Grant MacCurdy, secretary, Yale University Museum, New Haven, Conn.

UNIVERSITY AND EDUCATIONAL NEWS

THE board of regents of the University of Michigan has revised the faculty salary schedule of the literary department and the academic divisions of the engineering department. The revised and the original scales follow: Instructors, \$1,000–\$1,600, formerly \$900–\$1,400; assistant professors, \$1,700–\$2,000, formerly \$1,600–\$1,800; junior professors, \$2,100–\$2,400, formerly \$2,000–\$2,200; professors, \$2,500–\$4,000, formerly \$2,500–\$3,500. The revised scale affects 200 teachers, and increases the year's budget by approximately \$40,000.

CONTRACTS have been let for the construction of Ida Noyes Hall, the building which is to serve the women students of the University of Chicago as Bartlett Gymnasium and the Reynolds Club, provide for the physical culture and social needs of the men. This building, a gift of Mr. La Verne Noyes as a memorial to his wife, will be completed in January, 1916, at a cost of over \$450,000.

DR. ROGER I. LEE, of Boston, has been elected to the chair of hygiene recently established at Harvard University.

DR. HOWARD THOMAS KARSNER, assistant professor of pathology in the Harvard Medical School, has been appointed professor of pathology in the school of medicine of Western Reserve University.

DR. JOHN PENTLAND MAHAFFY, known for his work on Greek history, literature and social life, has been appointed provost of Trinity College, Dublin.

DR. ALDO CASTELLANI, director of the clinic for tropical diseases, Colombo, Ceylon, has been appointed by the Italian government professor of tropical medicine in the University of Naples, and the director of the royal clinic for tropical diseases in the same city.

DISCUSSION AND CORRESPONDENCE

A PECULIAR BEHAVIOR OF CUMULUS CLOUDS OVER THE ILLINOIS RIVER VALLEY

AT noon on a bright day in mid-August, 1914, the writer noticed over the valley of the Illinois River in Schuyler County, Illinois, a phenomenon which he deems worthy of record. The day was hot, with a brisk breeze from the west, and clear except for light cumulus clouds, uniformly and fairly closely spaced,

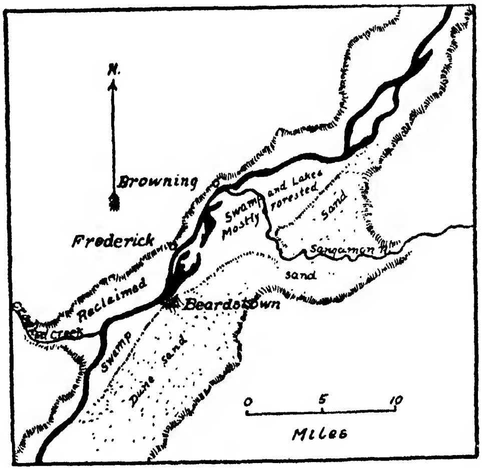

FIG. 1. Sketch of the portion of the Illinois River Valley along which the phenomenon here described was observed. Clear sky lay over the swampy and forested portion of the valley northeast of Beardstown while over the uplands and the reclaimed bottomlands cumulus clouds were observed. From the point of observation it could not be determined whether the clouds began again at the edge of the dune sand or at the eastern bluff.

moving rather rapidly with the wind. During a stop for lunch on the crest of the western bluff-border of the valley between Frederick and Browning (Fig. 1) attention was drawn to the movement of the cumulus clouds overhead. As a matter of curiosity a particular

cloud was selected with the idea of noting its changes of shape and something of its rate of movement. The cloud selected advanced to a point almost exactly overhead, then began to melt away. In a space of less than five minutes it had entirely disappeared. Another and yet another did the same. Finally, an unusually large cloud was selected; but this, too, disappeared on reaching approximately the same point. All advanced in orderly procession from the west till, overhead, they reached a lane of clear sky, then melted away.

This lane of clear sky, several miles wide, stretched away northeastward to the horizon, following very closely the course of the valley of the Illinois River, and southwestward over the river valley for 4 or 5 miles, after which it gave place to the usual cumulus clouds. To the east of the valley the cumulus clouds appeared once more and continued to the horizon. These relations were observed to persist throughout the greater part of the afternoon.

A possible explanation of the phenomenon which suggested itself at the time is here recorded as a working hypothesis to be considered in connection with similar occurrences which may from time to time be described. To make this explanation clear, a brief description of the geography of the region is necessary.

The valley of the Illinois River here is a flat-bottomed trough from 4 to 10 miles wide, bordered by relatively sharp bluffs, and is sunk some 200 feet below the general upland level of this part of the state. The upland is mainly cultivated farmland, much of it at this time of year bare after the wheat, hay and oats harvest. The river bottom, on the other hand, east of the point of observation and to the northeast as far as could be seen, is largely either swampy, with several lakes, or forest-covered. Four or five miles to the southwest, however, in the neighborhood of Beardstown, a considerable portion of the river bottom has been reclaimed and is given over to agriculture.

The explanation suggested is that over the upland farms numerous convection currents gave rise to cumulus clouds, while over the swamp and forest lands of the river bottom convection currents were subordinate or, perhaps, absent; that consequently, this cooler belt over the bottomlands not only failed to produce new cumulus clouds but also tended to become the channel of descent for some of the air which had been rising by convection from the surrounding hotter lands. On reaching such a belt of descending air, the clouds should be expected to melt away as they were drawn downward and to leave a zone of clear sky over the area of descending air. The width of the valley—4 to 10 miles—as compared with the height of the clouds—probably about one mile—should give ample opportunity for differences in heating to become effective in modifying the air currents and therefore the behavior of the clouds.

The presence of the cumulus clouds over the reclaimed parts of the bottomlands near Beardstown is thought to be significant in connection with the above explanation, since these would doubtless be heated nearly as effectively as the upland.

Other possible explanations of the phenomenon might be suggested, but it seems idle to speculate further until more observations of a similar nature have been made.

John L. Rich
University of Illinois

CYANIDE OF POTASSIUM IN TREES

To the Editor of Science: I note an interesting contribution to Science in the issue of October 9, on the subject of cyanide of potassium taken up by trees when put into holes in the same. I wish to report that this chemical is the chief basis of treatment by a firm in Allentown, Pa., doing an extensive business in some of the Eastern States, claiming to render trees immune from attacks by all insects and diseases, and also to fertilize them. The process was originated by a man named Kleckner, and is now continued by a company called the Fertilizing Scale Company, of Allentown, Pa. Their theory is that a tree can be given medicine, as well as food, by placing the same in capsules and fastening these in incisions under the bark. While the chief insect

poison is cyanide of potassium, yet they use chlorate of potash and sulfate of iron "to give the trees chlorine, sulfur, iron and potash." They make wonderful claims for the destruction of the scale and invigoration of trees, and commenced by charging fifty cents per tree for the so-called "vaccination." The price is now reduced to fifteen cents, but they are taking thousands of dollars from the confiding public.

The important scientific point is that I have examined hundreds of trees treated by them, and have in some instances found no evidences that scale insects were ever present, while in others I have found the San José scale alive on the trees some time after treatment. What is much worse is that I have found it is true that some one or more of these chemicals is evidently taken up in the sap of the tree, and that to a considerable extent. While the material was placed under the bark about three feet from the ground, it blackened the cambium layer as high as I could reach and remove the bark, and started blight or death of tissue at the place where inserted. I have the names of scores of persons whose trees or orchards were finally killed by this treatment. One man, whose name and address I can give, thought that it benefited his trees, and had it applied the second year, and the trees then died quickly. He is now disgusted with the treatment.

In company with Professor I. C. Williams, Deputy Forestry Commissioner of Pennsylvania, I visited an orchard in Lebanon County that had been treated a few weeks previously. The San José scale was found alive on the trees, but blight or death of tissue had commenced at the place of treatment and had worked downward slightly and upward considerably, and in fact, as high as one could reach. During the present week I have learned of another orchard, in Cumberland County, Pennsylvania, that was blighted and destroyed by the cyanide treatment. Therefore, while it is evident that some chemicals may be taken up in the trees and may even destroy some insects, it is further evident that they may be injurious to the trees, and should be applied with great care and only after considerable experimentation, and should be recommended by scientists only after great deliberation. I shall send to interested persons printed articles on this subject from the office of the State Zoologist, Harrisburg, giving names and addresses of persons whose trees have been killed by the cyanide "vaccination," as the fakirs call it. These may be published.

H. A. Surface,
State Zoologist
Department of Agriculture,
Harrisburg, Pa.

QUOTATIONS

RESEARCH AND TEACHING

There are at least three different conceptions of a university. To some men it means a group of technical schools which prepare for many distinct vocations; a place of universal study, as contrasted with one that pursues a single line only. To some men it means a place which is widely known for its teachers of science and literature and the discoveries that they are making; a school of universal reputation, as distinct from one whose fame is merely local. Still others think of it as a place where students can get wide range of knowledge and fit themselves for their duties as citizens of a self-governing community; a school with ideals of universal culture, rather than of narrow specialization.

The German university emphasizes the first and second of these conceptions; the French, the first and third; the English, the second and third. The American college in its early days devoted itself almost exclusively to the third. In attempting to become universities instead of colleges, our schools of higher learning in America have in recent years tried to combine all three aims; but often under such adverse conditions or with such inadequate resources that they have failed of actually attaining any one of them.

Under these circumstances a widespread belief has arisen that the three things should be separated rather than combined; that we

ought to have country colleges to give the students general culture, city technical schools to train them for their several callings, and research foundations, apart from college or technical school, to promote scientific discovery and other forms of intellectual achievement, by relieving the man who does creative work from the necessity of teaching.

Let us first examine the arguments of those who say that research ought to be separated from teaching.

The qualities of the investigator and the qualities of the teacher are quite different. A man may be good in one of these lines and bad in another. If investigators and teachers are associated in a university under the common title of professor, the tendency is to require every man who seeks a position at the head of his department to do something in both lines. The college is so largely dependent upon teaching for its revenue that it can not make any adequate payment to the investigator who does not teach. It is at the same time so dependent upon investigations for its outside reputation that it can not give the highest recognition and promotion to the teacher who does not investigate. Under these circumstances we get no proper division of labor. The man who ought to be making discoveries is compelled to waste his time in teaching students who can not appreciate and understand him. The man who ought to be teaching classes inspiringly and effectively feels himself compelled to do second-rate work of investigation which is of no inspiration to him or to anybody else. What is true of science is true of letters. The man who should be a creative author is made to do bad teaching. The man who should be an effective teacher is encouraged to write bad prose or worse poetry. To secure the advantages which the community can derive from proper division of labor—advantages which the community secures in every line of productive work except science and letters—we ought to have foundations which, by relieving our universities of the responsibility for progress in science and letters, will enable them to spend their money in paying adequate salaries to men who can teach. Such are the views of those who argue for the extrusion of research from our universities.

These arguments are plausible; to a certain extent, they are sound. Foundations to promote scientific discovery or literary production are admirable things. There are some men who can work more effectively without a university connection than with one; and it is most important to provide such men with opportunities. But if this idea were carried to the extreme, and it were understood that the universities were places for teaching and not for investigation, the result would certainly be bad for the universities themselves, and would probably be bad for the progress of science and letters as a whole.

For while it is true that the work of the investigator and the work of the teacher are different, it is not true that they are habitually separate or antagonistic. There are some productive scholars that can not teach at all; but the majority of them can teach remarkably well if you give them the opportunity to do it in the right way. On this point I may be permitted to quote a paragraph from my report of eight years ago:

> We are not dealing with an ordinary case of division of labor. The chief argument for division of labor is that it makes each man more expert and more efficient in his own field of work. In university work, however, the man who tries to investigate without teaching is apt to become sterile, while the man who attempts to teach without investigating becomes a worse teacher instead of a better one. We want the opportunities for research and investigation distributed as widely as possible throughout the teaching force and the student body. We want to impress upon every man that teaching and discovery are both done at their best when done in combination. Not that every man should be compelled to lecture to classes, whether he is able to do so or not. There is a great deal of valuable teaching which is not done in the class-room, or even in the laboratory. There are some men who teach best by their writings, their conversations, their intelligent suggestions for the work of others; but they should understand that they are part of the teaching force, and are simply doing their teaching in a dif-

ferent way from other men. Instead of setting such a man apart as a research professor, we should let him understand that withdrawal from the lecture room and relief from the duties of supervising elementary students carry with them a larger obligation to publish as fully as possible the results of all discoveries, to organize departments intelligently, to train up young men who can teach; and to make liberal room for such men, instead of trying to get in their way when their work becomes popular.

The routine work of teaching, if done under favorable conditions, is often a positive help to a scientific or literary man in keeping his nerves steady. Very few scholars, however productive, can write well all the time. Very few investigators, however well qualified, can make a continuous series of discoveries. If a man has nothing to occupy him in his less fertile intervals he will be tempted either to remain wholly idle or to publish second-rate books and pseudo-discoveries. A teaching position enables him to fill his time with work sufficiently close to his lines of productive activity to be stimulating and yet with enough of routine in it to make it healthful. And to most men this combination of teaching with research gives positive enjoyment of a high order. We may well remember the words of Lord Kelvin in connection with his receipt of the degree of Doctor of Laws from Yale in 1902:

> There is one point on which I specially desire to speak. College professors should be permitted and given the means to do research work. On this matter of research I feel deeply. At the same time I do not believe it wise to have a research laboratory without teaching. It is a pleasure for a professor to meet students and to tell them what he can, and a greater pleasure if he can make them understand, and the greatest pleasure if he can widen the borders of their knowledge. To combine research work with teaching is most valuable both for student and teacher.

This is not intended as an argument against the establishment of institutions for research. There is room outside of the universities for all the endowments which we now have for productive work in science and letters, and for many more. There is as much difference of temperament among investigators as there is among men of any other kind. Some do better research work when they are relieved of the necessity of teaching. For these we should have independent foundations. Others, whom I believe to be a decided majority, do better research work in connection with university positions. I regard it as a most fortunate circumstance that we are able to make provision for men of both kinds.

Nor is this intended as an argument against appointing men to professorial positions who are inspiring teachers rather than productive scholars. Our colleges need all the good teachers that we now have, whether they are productive scholars or not. But with a large number of men good teaching and productive scholarship ought to be conjoined; and it would be most unfortunate for such men themselves, for our universities, and for America's progress in science and letters, if we attempted to dissociate things that so generally belong together.—From the annual report of President Arthur T. Hadley, Yale University.

SCIENTIFIC BOOKS

List of Prime Numbers from 1 to 10,006,721. By DERRICK NORMAN LEHMER. Carnegie Institution of Washington, Publication No. 165, 1914. Pp. xv + 133.

By the publication of his factor table for the first ten million natural numbers (Publication 105, Carnegie Institution of Washington, 1909) Professor Lehmer offered to the public a monumental work which will probably remain a model of its kind for centuries in view of its accuracy. The present work is based upon this factor table and was prepared with equal care. The pages are of the same size in these two publications, but the present volume is not quite one third as large as its predecessor.

Since the natural numbers are fundamental in many mathematical theories, it is not infrequently useful to know whether a given number is prime. The direct determination of this property is generally very laborious when the number is large. Hence a reliable table may save an enormous amount of labor.

On the other hand, such a table is very useful as a check in the development of theorems relating to prime numbers. Mathematical interest along this line has been greatly stimulated in recent years by the publication of the elegant work, in two volumes, entitled "Handbuch der Lehre von der Verteilung der Prinzahlen" by E. Landau, of Göttingen, Germany.

The prime numbers contained in the present volume can be found by means of the given factor table, but it is much easier to use the present table in case the only question under consideration is whether a given large number, within the limits of this table, is prime or composite. Each page contains 100 rows and 50 columns of numbers, and hence there are 5,000 different prime numbers on a page. It is therefore very easy to determine, by means of this table, the number of prime numbers lying between any two numbers within the limits of the table.

The Introduction covers fifteen pages and deals with various questions relating to prime numbers. It includes a table exhibiting the actual numbers of prime numbers at intervals of 50,000 up to 10,000,000, and comparing them with the approximate numbers of these primes according to the formulas of Riemann, Tchebycheff (Čebyšëv) and Legendre. It is somewhat surprising to find that the Introduction contains evidences of carelessness while the body of the work seems to have been prepared with the greatest care.

In fact, at least three inaccuracies appear on the first page of the Introduction. Line twenty begins with the word "infinite" instead of "finite." In line thirty-seven of the first column it is stated that Eratosthenes was a contemporary of Euclid. As a matter of fact it is not known whether Euclid was still living when Eratosthenes was born. We know very little about the life of Euclid, and it is distinctly stated in Günther's "Geschichte der Mathematik," 1908, page 83, that we do not know whether Euclid and Eratosthenes were contemporaries. In line sixteen of the second column of the first page the symbol 2^{2n} should be replaced by $2^2{}_n$.

In referring to these inaccuracies in the Introduction it is not implied that they affect seriously the value of the book. On the contrary, we desire to emphasize the fact that the table is not to be judged by its Introduction. Professor Lehmer realizes very keenly the great importance of accuracy in listed results, and he has made a careful study of methods which tend to insure the greatest possible accuracy. In view of the enormous amount of labor involved in testing the accuracy of such tables sufficiently to pass reliable judgment, the reviewer bases his confidence in the accuracy of the present table on the methods used by the author, and not on his own direct observations.

In closing we may refer briefly to the following interesting sentence which appears on page x of the Introduction: "It is hardly likely, indeed, that any theorem of importance in the Theory of Numbers was ever discovered which was not found in the first place by observation of listed results." Professor Lehmer's comprehensive knowledge of the developments in Number Theory gives great weight to this striking emphasis on the importance of listed results. To the reviewer the quotation appears to emphasize too much the usefulness of the method under consideration, especially as regards the developments in the theory of algebraic numbers.

G. A. Miller
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Natural Sines to Every Second of Arc, and Eight Places of Decimals. Computed by E. Gifford from Rheticus. Manchester. Printed by Abel Heywood & Son, 47 to 61 Lever Street. 1914. Pp. 543.

Among the extensive trigonometric tables which were calculated during the sixteenth century those of Rheticus occupy the most prominent place. That an immense amount of labor, devotion and perseverance was involved in the preparation of such tables may be seen from the fact that Rheticus employed computers for twelve years at his own expense.[1] His "Opus Palatinum," published posthu-

[1] Braunmühl, "Vorlesungen über Geschichte der Trigonometrie," Vol. 1, 1900, p. 212.

mously in 1596, contained tables to ten decimal places of the natural trigonometric functions at intervals of ten seconds. This was surpassed in 1613 by the tables in the "Thesaurus Mathematicus," which were based by Pitiscus upon unpublished tables computed by Rheticus, and gave the values of the natural functions to fifteen decimal places.

Soon after the appearance of these extensive tables the public began to realize the great advantages of logarithmic computation. The "Trigonometria Britannica" by Briggs and the "Trigonometria artificialis" by Vlacq appeared in 1633, and served as sources for numerous briefer logarithmic tables of trigonometric functions. For about three hundred years it appeared as if the greater part of the labor put on the natural function tables had been wasted. In recent years calculating machines have to a considerable extent replaced logarithmic tables, and have brought the natural function tables into more prominent use; thus furnishing another instance of unforeseen usefulness of mathematical lore.

In 1897 W. Jordan published a table of the natural trigonometric functions to seven decimal places, basing his work upon the "Opus Palatinum." To-day we have before us this work by E. Gifford based on the tables of Rheticus and aiming to facilitate the use of these tables by computing the values of the natural functions from second to second by interpolation. In view of the recent refinement in observation seven place tables do not always secure sufficient accuracy. Hence the present tables are computed to eight decimals.

One of the most important elements in such tables is accuracy. As the main tables of Rheticus have been improved by successive computers it would appear that serious inaccuracies in such tables as the present could easily be avoided. The author of the present table does not inform us as regards his precautionary measures except that "the sines to 1″ were interpolated by the Thomas calculating machine from Rheticus's figures for 10″, each being copied to 10 places and obvious mistakes corrected so that the differences run in descending series." It is a somewhat curious fact that at the top of the first page of the table we find cosine 1 in place of cosine 90°. G. A. MILLER

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Zur Frage der Entstehung maligner Tumoren. By TH. BOVERI. Jena, Gustav Fischer. 1914. 64 pages.

The eminent position held by Professor Boveri in the field of cytology, if for no other reason, entitles him to a careful hearing in any allied field of research, and the present highly suggestive hypothesis as to the origin of malignant tumors is by no means inappropriate from him since the tumor problems in their last analysis are cell problems. The medical man will probably pay little attention to this theory because it offers no practical solution of the cancer problems. Medical men interested in the theories as to the causation of cancer, and especially those who follow von Hansemann, however, will find in Boveri's hypothesis a most interesting and suggestive *modus operandi* for their favorite theory.

In any hypothesis of cancer origin the difficulty to be overcome is the phenomenon of unrestricted cell division of the malignant cancer cells. This is the crux of the whole matter and it is here that every current hypothesis of cancer origin falls down, but in Boveri's hypothesis this point is met.

The theory rests upon a number of assumptions, some of which are supported by experimental evidence, some are purely conjectural. We may briefly summarize these assumptions as follows: First, the chromosomes are qualitatively different and a certain number and assortment of them are necessary for normal balanced activities of the cell; second, abnormal mitosis in the form of multipolar spindle formation, leads to unequal distribution of the chromosomes in the resulting cells; third, lost chromosomes are never replaced and the abnormal cell, if it divides further, must give rise to similar abnormal cells; fourth, such an abnormal cell with its chromosome complex has a different set of interactions with the surrounding tissues

and with the organism as a whole, than does the normal tissue cell (or, as an alternative assumption, there may be in the nucleus special division-forcing or division-preventing chromosomes); fifth, a malignant cancer cell is one having an abnormal chromosome complex which continually reacts to a division stimulus from the surroundings, or in which the division-preventing chromosomes are absent, or in which possible division-forcing chromosomes are present in multiple number; sixth, the malignant tumor always arises from one single cell; seventh, this primordial cancer cell arises by abnormal division of an otherwise normal tissue cell and may start from any one of a large number of different causes.

Of these assumptions the first, second and third are supported by experimental evidence; the fourth may be accepted as a corollary from the experimental evidence. The remainder, while based upon the experimental evidence, are not supported by direct evidence.

The experimental evidence is based upon the well-known work by Boveri himself on dispermic eggs of the sea-urchin in which, through multipolar spindles, the chromosomes are irregularly distributed in the four resulting cells. Such four-cell stages, submitted to the action of Herbst's decalcified sea water, separate and develop on immersion in normal sea water. The variety of irregular and abnormal larvæ resulting from this treatment indicate the qualitative differences of the chromosomes and the need of a balanced chromosome complex. Further experimental evidence of the qualitative difference of chromosomes is furnished by the modern work in cytology and in experimental breeding, especially in connection with the sex chromosome. Observations and experiment have led to the general acceptance of the theory of the individuality of the chromosomes and of the conclusion that a chromosome, once lost, can not be replaced or regenerated from other chromosomes.

That single chromosomes of tissue cells of vertebrates represent different activities in the cell is the basic assumption in Boveri's cancer theory. In his earlier experimental work he showed that some chromosomes might be absent without causing ill effects on the further activity of the cell, while the loss of others would be shown by pathological effects on future structures and activities. If the same principle holds for tissue cells, an abnormal mitosis might give rise to cells with an unequal distribution of chromosomes, and such cells might have a chromosome complex which would permit the ordinary, controlled activities of the cells of that particular tissue, and the result would be relatively harmless; or, one of such cells might have an abnormal chromosome complex in which the controlling factors of division are either absent or overbalanced and unlimited growth and division would result. Not every abnormal mitosis in normal tissue cells would thus lead to tumor formation but only such as have the abnormal chromosome complex which represents an uncontrolled growth and division energy. His theory thus demands that a given cancer arises from one original cancer-producing cell which transmits its chromosome complex and its abnormal peculiarities to all of its daughter cells and so gives to the cancer, as a whole, its peculiar cellular characteristics. The theory has nothing to do with abnormal mitoses in the cancer cells themselves; such abnormal mitoses tend to break up the peculiar and malignant chromosome complex and to render the progeny of such cells harmless. In a sense therefore, abnormal mitoses in cancer might be indicative of spontaneous healing, although by the theory it is equally possible that a new and more malignant type of cancer might be started.

The cause of a malignant tumor, according to this hypothesis, thus may be anything which induces abnormal mitoses; for example, chronic irritation sets up regenerative processes and continues to act during the mitotic processes involved in this regeneration. One or several mitotic figures might be broken up by such irritation thus giving rise to unequal distribution of chromosomes in the resulting cells, some or one of which might have the chromosome complex necessary for continued

proliferation, abnormal inter-actions, and to cancer formation.

The abnormal activities of cancer cells, together with the products of necrosis present in every cancer, may induce cell division and the formation of cells with the right chromosome complex for cancer origin, in neighboring tissues, and so start up secondary or tertiary growths from the primary, thus giving rise to the phenomenon occasionally met with in transplanted tumors of change in type, carcinoma into sarcoma, for example, as Bashford has found.

The varying frequency of cancer in different organs or tissues depends, according to this theory, upon the frequency of mitotic divisions in the normal tissues; the age incidence of cancer, upon the abnormal divisions which accompany physiologically weakened cells, as in the case of protozoa in "depression" periods.

In his treatment of the theory Boveri gives its application to most of the well-known phenomena met with in cancer growth, and meets some of the arguments which have been brought against it. From the nature of the case the theory is difficult if not impossible to analyze by direct experiment, and for this reason, as well as for its impracticability, it is probable that the hypothesis will not be favorably received by the medical profession.

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A Text-book of Geology, for use in mining schools, colleges and secondary schools. By James Park, Professor of Mining in the University of Otago, New Zealand. London, Charles Griffin & Co. 1914. 8vo. Pp. xvi + 598, Figs. 263, Pls. 70.

Professor Park has already become well-known to teachers and students of geology in America by his writings upon mining geology. His cosmopolitan attitude and broad sympathies are attested in the present text-book by a frontispiece from the Grand Canyon of the Colorado, and by acknowledgments, in his preface, to the director of the U. S. Geological Survey for aid kindly extended. A reader on this side of the world would naturally anticipate a text-book specially prepared for Australasia, but one is pleasantly surprised to find that the anticipations are not borne out by the facts. European and American geological sections and remains of life are discussed with the same fulness as Australasian. One can not help wishing that for readers on this side of the world a little more emphasis had been laid on the latter.

Professor Park's text-book is of about the same size and scope as Scott's "Introduction to Geology," or LeConte's "Elements." It will furnish the material, along with laboratory study and suitable field trips, for one year's work in a college or scientific school. It impresses the reviewer as too advanced for secondary schools, despite its title.

There are, of course, several lines along which the subject of geology may be attacked or expounded. Broad, general processes such as erosion and deposition, elevation and subsidence, may be set forth in advance of the handling and learning of minerals and rocks. Or the teacher, as seems best to the writer, may begin with actual rocks and discuss these first; passing later to their large forms and their erosion, disturbance and order in time. A third start is possible if one considers the earth in its astronomical relations and later comes down to the terrestrial details. Professor Park begins with a summary of the science in all its bearings, and in his first chapter outlines the general astronomical relations, history, structure and the play of modifying processes. The chapter closes with seventeen summarizing propositions. Chapter II. in two pages blocks out the subdivisions of the subject and briefly reviews the teachings of several of its founders. Passing then to denudation and the destructive and constructive effects of streams, oceans, and the resulting general rock structures, nine chapters, or about one third the work, are utilized before the rock-forming minerals and the rocks themselves are specifically taken up. One may question if it would not be clearer to a student if the rock-making minerals and the rocks themselves, as formed of them, could

not be most wisely studied first, as they can be, without extended reference to other parts of the subject; and then knowing the raw materials with which forces and processes deal, the student can most intelligently follow out the various modifications produced upon them by the geological agents.

Professor Park does not take up rocks as objects in and of themselves, but views them as products of geological processes. Thus, sedimentary rocks are first outlined following the introductory chapters already mentioned, and even after joints, faults and cleavages have been described. Igneous rocks are introduced by a preliminary chapter on volcanoes and volcanic action. Before the individual rocks are taken up we find the topics—alteration, magmatic differentiation and Atlantic and Pacific types discussed, inevitably with the use of rock names with whose significance the student can not yet be familiar. In these particulars it seems to the reviewer that the natural order of treatment is reversed.

A chapter on fossils and a following one on conformity and unconformity lead up to the great subject of stratigraphical geology which forms Part II., and to which fifteen chapters or more than one third the work are devoted. One hails with satisfaction this recognition of the great stratigraphical part of the subject, by one who writes primarily for mining schools. The tendency to minimize this enormously important branch of the subject in favor of purely structural and dynamic portions has become pronounced in later days, and yet mistakenly. The great conceptions of older and younger strata, of succession in time, of recognition by organic remains; of the growth of land masses, are all fundamental to the applications of the subject as well as to its proper understanding. The treatment is well balanced and the succession of living forms is brought out by reasonably full numbers of illustrations. Sections are given for all the better explored portions of the globe.

Part III., Economic Geology, embraces two very condensed chapters, one relating to mineral deposits of all kinds and one on the methods of field work and geological surveying. Besides two brief appendices on special field methods, a condensed bibliography of geological works, classified by subjects, is given at the close of the work. All in all, Professor Park's work is well written, interesting, and will prove a serviceable text-book.

J. F. Kemp

BOTANICAL NOTES

A STUDY OF A DESERT BASIN

Several months ago there appeared from the Carnegie Institution of Washington, as "Publication No. 193" an interesting paper entitled "The Salton Sea," by Dr. D. T. MacDougal and his collaborators. It fills a quarto volume of nearly two hundred pages, and is illustrated by thirty-two full-page plates, and four text figures.

The whole book is full of interest to the scientific reader, and especially to the geologist and geographer, as shown by the titles of the chapters, "The Cahuilla Basin and Desert of the Colorado"; "Geographical Features of the Cahuilla Basin"; "Sketch of the Geology and Soils of the Cahuilla Basin"; "Chemical Composition of the Water of Salton Sea, and its Annual Variation in Concentration," etc. Several of the chapters, including the major part of the volume, are devoted to botanical aspects connected with the formation and recession of the limits of the Salton Sea. And here it may be remarked that this sea is in southern California, and occupies a portion of a great desert depression of the earth's surface below sea level. The sea was formed a few years ago by an inrush of water from the Colorado River which flooded an area of over four hundred square miles of the lower portions of the Cahuilla Valley. Since then the sea has been subsiding, and this fact has enabled the botanists to study the incoming vegetation under the peculiar conditions here found.

The distinctly botanical chapters are those on the "Behavior of Certain Microorganisms in Brine"; "The Action of Salton Sea Water on Vegetable Tissues"; "Plant Ecology and Floristics of Salton Sink"; "Movements of

Vegetation due to Submersion and Desiccation of Land Areas in the Salton Sink," and the final "General Discussion." In the third of these there is given a catalogue of 202 species of plants collected in the Salton Sink. Of these, 23 species are lower (spore-bearing) plants, while 179 are seed-bearing. Of the seed-plants 131 are indigenous, and 48, introduced, the latter almost wholly confined to the reclaimed areas (by irrigation and cultivation), and it is said that in no case have they been able to intrude where natural (*i. e.*, desert) conditions remain.

In the fourth chapter "the main thesis has been the manner in which seed-plants were carried into moist zones or strands around the receding lake which had been completely sterilized by immersion in the salt water." During the six years of close observation five trees, 17 shrubby species, and 38 herbaceous forms appeared upon the beaches of the receding lake. Lists are given of the earlier species to appear on the newly emersed beaches, but their significance is hard to understand, no doubt because of the many factors entering into the problems of dissemination, succession, elimination, etc. The transformation of a waterless desert of excessively high temperature into a saline lake with broad beaches, which range through all degrees of moisture from soft mud to almost complete desiccation, involves a great number of physical and biological factors, and this paper is a notable contribution to this phase of botany, which will be of interest to all ecologists.

VASCULAR PLANTS OF OHIO

THE state of Ohio is fortunate in having had for so many years a succession of systematic botanists who have gone over their territory again and again until its higher plants are now very well known. Fifteen years ago the lamented Professor W. A. Kellerman with the help of a considerable number of contributors published the "Fourth State Catalogue of Ohio Plants," and now his successor, Professor J. H. Schaffner, issues another list under the title "Catalogue of Ohio Vascular Plants."[1] As indicated by its title it is confined to the higher plants, and includes 2,065 species, "about one fourth of which are non-indigenous."

The nomenclature conforms mainly to that of the second edition of Britton and Brown's "Illustrated Flora of the Northern United States, Canada, and the British Possessions," and the arrangement is in accordance with the well-known phyletic classification proposed by the author of the publication. Thus the phyla are Ptenophyta (Ferns, 49 species): Calamophyta (Horsetails, 8 species); Lepidophyta (Lycopods, 8 species); Strobilophyta (conifers, 11 species); Anthophyta (Flowering Plants, 1,989 species). Among the flowering plants one finds 526 monocotyledons, against 1,463 dicotyledons. Again we find 161 sedges (Cyperaceae), and 178 grasses (Graminaceae). So, in the dicotyledons we find 72 mustards (Brassicaceae); 94 rosaceous plants (Rosaceae, in the wider sense); 87 legumes (Leguminosae, in the old sense, although listed under Fabaceae); 6 ragweeds (Ambrosiaceae); 202 composites (Helianthaceae); 25 chicories (Cichoriaceae).

A convenient map of Ohio showing the counties, and a full index complete this notable catalogue.

A STUDY OF A CARBONIFEROUS FLORA

IN a paper entitled "The 'Fern Ledges' Carboniferous Flora of St. John, New Brunswick," published as Memoir 41, of the Geological Survey of Canada (1914) Dr. Marie C. Stopes gives descriptions of the species of plants from these interesting deposits. The genera *Calamites, Asterophyllites, Annularia, Sphenophyllum, Lepidodendron, Sigillaria, Stigmaria, Psilophyton, Sphenopteris, Crossotheca, Diplothema, Oligocarpia, Pecopteris, Alethopteris, Megalopteris, Adiantides, Neuropteris, Trigonocarpum, Rhacopteris, Sporangites, Pterispermostrobus, Whittleseya, Dicranophyllum, Cordaites, Poacordaites, Dadoxylon, Cordaianthus* and *Cardiocarpon* are represented by one or more species. Many of these are illustrated by half-tone reproductions

[1] Ohio State University Bulletin, No. 24.

of photographs of the actual specimens. Since these half-tones have not been "touched up" they must prove of the greatest value to students of Carboniferous plants.

A USEFUL SOCIETY

The Sixth Annual Report of the "Quebec Society for the Protection of Plants from Insects and Fungous Diseases" (Quebec, 1914), calls attention to a society that must prove to be most useful to the people of the province of Quebec in particular, as well as of all eastern Canada in general. The report itself covers less than a hundred pages, and yet it includes more valuable articles than many much larger reports. Thus among botanical papers there is a short, crisp report of the committee on the flora of the province of Quebec recommending the early publication of a new "Flora of Quebec"; another on Downy Mildews; still others on Some Plant Diseases of 1913; Storage Rots of Potatoes and Other Vegetables; A Bacterial Soft Rot of Turnips; Injury and Abscission of *Impatiens sultani*. One can not help feeling that these Canadians have managed to organize a most useful society, for which they deserve to be congratulated.

Charles E. Bessey
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SPECIAL ARTICLES

THE ELECTRIC MOTOR NERVE CENTERS IN THE SKATES (RAJIDÆ)

While the electric lobes of the brains of torpedos, with their massed motor nerve cells of the electric apparatus, are classic subjects of study, and while the physiologically corresponding motor centers of the central nervous system have been described superficially in *Malopterurus, Gymnarchus* and *Gymnotus*, the motor nerve apparatus of the other three types of electric fishes (two Teleosts) have never been adequately worked out. The writer has recently worked on this nerve center of the electric apparatus in the skates with results that promise to be of interest.

Ewart has already described a motor electric nerve cell from Raja, but it is not certain that the cell, which he figures and describes in his short report in the *Proc. Royal Soc.*, Vol. 53, pp. 388–391, is a motor nerve cell belonging to the electric organ or a motor nerve cell belonging to the muscle that surrounds the electric organ.

The writer examined the spinal cords of eleven species of skates and found remarkable cells placed in the anterior horn of the cord at various regions which were all opposite the well-known spindle-shaped electric organs found in the tail and lower body of this fish. While these cells were placed thus in the cord among other nerve cells and corresponded in their anterior-posterior distribution with the extent of the electric organ, yet their cytological character was such that it could scarcely be believed that they were nerve cells at all. They are of unusually large size, irregular in configuration, with many angles and projecting points some of which might be nerve processes. The large cytoplasmic body contains an irregular branching and lobular nucleus containing much chromatin but no definite plasmosome, the opposite condition to that found in most nerve cells. This chromatin is distributed in the form of numerous (several hundred) masses of considerable size, evenly and regularly strewn through the caryoplasm.

This type of nucleus is so unusual for a nerve cell that these cells were traced backward through a series of embryonic skates to their origin, which proved to be the same as the other motor nerve cells of the anterior horn. Stages were clearly traced that showed them being differentiated from these other cells at an early stage of the embryo within the egg. The physiological activity of these large cells was evidenced by the formation of series of vacuoles which coalesced into larger vacuoles that finally condensed and precipitated their contents into a number of heavy, homogeneous granules which were discharged from the cell in a ventral direction and became distributed through and around the tissues of the gray matter. This material appears to be finally absorbed by the blood. Its composition has not yet been determined.

Work on this whole apparatus and its products is being pursued by Mr. C. C. Speidel and the writer to determine its structure and function, which is supposed to have some relation to the electric apparatus of the skates, even if it does not prove to be the motor nerve cells of this apparatus.

ULRIC DAHLGREN

THE EFFECT OF STORAGE IN RIVER WATER (STERILIZED) ON THE PRODUCTION OF ACID IN CARBOHYDRATE SOLUTIONS BY THE BACILLUS COLI GROUP

DURING the last decade, the fermentation of the various carbohydrates with the production of acid and gas has been used almost exclusively for dividing the *Bacillus coli* group into many subdivisions. Theobald Smith (1893) seems to have been the pioneer in this field by his division of the colon group by the use of saccharose. Of the later workers, Winslow and Walker (1907) and MacConkey (1905) seem to have done the most careful work. MacConkey divided the *Bacillus coli* group into four subgroups by the use of dulcite and saccharose according to the following scheme:

	Saccharose	Dulcite
B. coli communis ..	—	+
B. coli communior ..	+	+
B. coli aerogenes ...	+	—
B. coli acidi lactici.	—	—

In 1909 MacConkey further subdivided the groups by the addition of motility and liquefaction of gelatine to his tests. Jackson (1911) in America subdivided MacConkey's original scheme by the use of mannite, raffinose, nitrate reduction, indol production, motility and other similar reactions. The fermentation of carbohydrates certainly offers a fruitful field for the classification of the *Bacillus coli* group, but we must soon decide just what the limits of fermentation must be, for the list of carbohydrates now in use is a long one and increasing steadily. The question will soon come to the front, "Are these fermentations of the various carbohydrates permanent functions of the organisms?" Horrocks (1903) found that members of the *Bacillus coli* group which were kept in sterilized sewage and Thames River water as well as in well water showed only a weak production of indol and a delayed action on milk. Peckham (1897) also found that the production of indol is variable. The purpose of the present work was to determine the permanency of acid production in carbohydrate solutions by the *Bacillus coli* group in stored river water. Three organisms of the original MacConkey scheme were used, namely, *B. coli communis, acidi lactici, aerogenes.*

Procedure

Water was taken from the Hudson River near the outlets of a sewer and 100 c.c. was poured into 30 bottles of 250 c.c. capacity. The water was sterilized and the sterilization tested by plating out respective samples. Pure agar cultures of *B. coli communis, aerogenes, acidi lactici* were emulsified in sterilized water. One cubic centimeter of this emulsion was placed in each bottle thus giving ten bottles of *communis, acidi lactici* and *aerogenes.* These bottles were stored away in a dark closet at 20° C. At various intervals inoculations were made into the carbohydrate solutions and titrations made at the end of the twenty-fourth hour or as near as possible to that period. During the course of the experiment the following carbohydrates were used: Dextrose, lactose, raffinose, saccharose, salicin, maltose and mannite.

The carbohydrates and other media used during the work were made according to standard methods of water analysis, report of 1905. Liebig's Meat Extract (3 grams to the liter) was used in place of meat and gave entirely satisfactory results. The method used in titrating the cultures followed standard methods in detail. Five cubic centimeters of the carbohydrate solution to be tested and 45 cubic centimeters of distilled water were placed in a casserole and boiled briskly for 1 minute. One cubic centimeter of phenolphthalein was added as indicator, and titration was made into the hot solution with N/20 NaOH. All results are expressed in per cent. normal. All cultures were incubated at 37° C. and titrated at the twenty-fourth hour. Controls were run

in all cases. The author wishes to thank Meyer M. Harris for the routine analyses.

TABLE I

Averages of the Production of Acid by Bacillus coli communis

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	2.71[1]	2.02	2.15	No acid produced	2.87	No acid produced	1.83
1	2.73	2.12	2.01		2.88		1.73
2	2.71	2.09	2.01		2.82		1.69
3	2.79	1.77	2.00		2.36		1.54
4	2.78	1.81	2.03		2 34		1.52
6	2.76	1.78	2.11		2.35		1.54
8	2.44	1.88	1.81		2.34		1.49
10	2.39	1.84	1.78		2.17		1.38
14	2.41	1.98	1.77		2.09		1.39

TABLE II

Averages of the Production of Acid by Bacillus coli aerogenes

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	2.76[2]	1.95	1.97	2.08	2.63	2.03	No acid produced
1	2.80	2.22	2.09	2.64	2.62	1.48	
2	2.77	2 09	2.16	2.66	2.49	1.53	
3	2.81	2.05	2.03	2.17	2.34	1.68	
4	2.75	1.86	1.96	1.90	2.30	1.61	
6	2.78	1.75	2.03	1.94	2.29	1.58	
8	2.47	1.76	2.03	1.95	2.32	1.60	
10	2.34	1.77	1.79	1.82	2.16	1.59	
14	2.27	1.80	1.81	1.77	2.13	1.58	

TABLE III

Averages of the Production of Acid by Bacillus coli acidi lactici

Length of Storage in Weeks	Dextrose	Lactose	Maltose	Saccharose	Mannite	Raffinose	Salicin
0	lost	1.96	2.46	No acid produced	2.82	No acid produced	1.65
1	2.80[3]	2.00	2.14		2.62		1.19
2	2.81	2.00	2.15		2.69		1.46
3	2.76	1.81	2.24		2.39		1.44
4	2.74	1.83	2.20		2.29		1.39
6	2.76	1.91	2.29		2.32		1.38
8	2.22	1.83	2.15		2.27		1.42
10	2.06	1.85	1.89		2.23		1.33
14	2.05	1.82	1.86		2.16		1.34

[1] Each result is the average of ten titrations.
[2] Each result is an average of ten titrations.
[3] Each result is an average of ten titrations.

Conclusion

From the tables of averages it may be seen that storage for a period of 14 weeks in sterilized Hudson River water (in tidal area) has very little effect upon the amount of acid produced in dextrose, lactose, saccharose, maltose, mannite, salicin and raffinose by various members of the *Bacillus coli* group, *i. e., Bacillus coli communis, aerogenes* and *acidi lactici,* which indicates that production of acid is a permanent characteristic of the *Bacillus coli* group. The slight decline of acid production may be due to diminished vitality of the organisms as a result of long storage in the water.

WM. W. BROWNE
THE COLLEGE OF THE CITY OF NEW YORK

THE WASHINGTON MEETINGS OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS AND RELATED ORGANIZATIONS

THE twenty-eighth annual convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 11–13, 1914, and accompanied as usual by meetings of about half a score of related organizations, brought together college presidents, experiment station and extension directors, and workers in many fields of agricultural science to the number of approximately five hundred. The sessions of the various bodies were well attended and enthusiastic, and the programs included much of interest to educators, scientific men and the general public.

The complete list of organizations included in these meetings was as follows: American Association of Farmers' Institute Workers, November 9–11; American Farm Management Association, November 9, 10; American Society of Agronomy, November 9, 10; National Association of State Universities, November 9, 10; American Association for the Advancement of Agricultural Teaching, November 10; Society for the Promotion of Agricultural Science, November 10; American Society of Animal Production, November 10,

11; Land-grant Engineering Association, November 11–13; Association of Official Seed Analysts, November 12, 13; Association of Feed Control Officials of the United States, November 13, 14, and Association of Official Agricultural Chemists, November 16–18.

The general sessions of the Association of American Agricultural Colleges and Experiment Stations opened November 10. In an address of greeting, the Secretary of Agriculture, Hon. D. F. Houston, spoke of the increasing realization of the unity of interests of the department and the agricultural colleges, and of the widened opportunities for service through this and through the passage of the Smith-Lever extension act. He also emphasized the additional responsibilities incurred, and especially the difficulty of securing trained men to take up these new undertakings. The development of strong rural economics courses to provide workers in such lines as marketing studies and the making of country life more attractive was strongly urged upon the agricultural colleges as well as their assumption of a general position of leadership in country life matters.

In the report of the bibliographer, Dr. A. C. True, of the Office of Experiment Stations, discussed the form of extension publications, calling attention to the great diversity of practise now prevailing, and suggesting some changes in the interests of uniformity, increased availability, and ease of preservation of these publications. Subsequently, a series of recommendations from the agricultural libraries section of the American Library Association as to title pages, pagination and similar matters in college and station publications in general received the consideration and approval of the executive committee of the association.

For the standing committee on instruction in agriculture, Dr. True reported as chairman on farm practise requirements as a part of the 4-year college course. Much diversity among institutions was discovered but the importance of the subject was strongly emphasized. It was pointed out that failure to make provision for such practise decreases the effectiveness of instruction in agriculture, and that students who are permitted to graduate without it often bring upon the colleges merited unfavorable criticism. The report is to be printed as a separate at an early date.

Dr. H. P. Armsby, of Pennsylvania, reported for the committee on graduate study, dealing especially with the Sixth Graduate School of Agriculture successfully held at the University of Missouri, June 29 to July 24. A policy of concentration upon a few subjects at the school was favored as well as the provision of some form of credit for work accomplished, and the need of greater attention by the colleges and stations to ways for facilitating the attendance of the younger members of their staffs at this school was pointed out.

Reports were also submitted by the standing committees on college, experiment station and extension organization and policy. A plan for student and faculty cooperation being tried at the Iowa State College in such matters as the upkeep of the grounds, sanitation and other minor improvements, and the protection of property was briefly reported by the college committee. This committee also summarized a questionnaire as to student character records which indicated a general belief in the desirability of such records but little uniformity as to methods. The experiment station committee emphasized the need for a sharp differentiation of the field of the station work from that of extension agencies, limiting the scope of the station to the discovery of new facts and methods and the testing of them to a point sufficient to establish their general truth and application. The prompt publication of results and the preservation of records in such form that in case of necessity the work may be taken up by others and the wider utilization of the *Journal of Agricultural Research* were also recommended. The report of the extension committee consisted largely of descriptions and definitions of terms commonly used in extension work. The question of general agricultural terminology is also to receive further study by a special committee subsequently authorized by the association.

The joint committee of the association and the U. S. Department of Agriculture on projects and correlation reported through Dean F. B. Mumford, of Missouri, that the committee had examined about 1,300 projects submitted by the state institutions and about 1,000 from the Department of Agriculture with a view to their possible correlation. Dr. K. F. Kellerman, of the department, for the joint committee on publication and research, explained the policies of the *Journal of Agricultural Research*, now open to experiment station workers, and urged a wider participation by them.

The evening sessions of the association were devoted largely to the address of the president, Dr. A. C. True (already printed in SCIENCE) and to addresses by E. L. Morgan, of Massachusetts, and Miss Elizabeth B. Kelley, of Wisconsin. Professor Morgan described an interesting experiment in rural community planning inaugurated in a typical New England village by the Massachusetts Agricultural College, whereby a strong community spirit was developed and great improvement effected in agricultural practise and marketing, transportation facilities and other civic affairs, in education, and in the adoption of an all-the-year-round plan for community recreation. Miss Kelley spoke on home economics in extension work and emphasized the importance of educating men as well as women along this line, outlining some of the ways which have been found effective in bringing improved methods into the home.

One of the general sessions was set aside for the discussion of problems in connection with the administration of the Smith-Lever extension act. At this session, President W. O. Thompson, of Ohio, chairman of the executive committee, reviewed the passage of the measure and Dr. True, for the States Relations Committee of the U. S. Department of Agriculture, described its practical workings. The matter was further discussed by Dean C. F. Curtiss, of Iowa, President A. M. Soule, of Georgia, A. D. Wilson, of Minnesota, President Benjamin Ide Wheeler, of California, and others. Hon. Carl Vrooman, Assistant Secretary of Agriculture, also made a brief address at this session in which he pointed out the need of extension work. At its close the association was received at the White House by President Wilson.

At the final session, a report was made by President Brown Ayres, of Tennessee, for the executive committee, on the provisions and status of the Smith-Hughes bill for federal aid to vocational education, including an explanation of the work of the Federal Commission on Vocational Education. Commissioner Claxton and others also discussed the scope and details of the bill. The association declared itself in favor of federal aid to vocational education along the general lines of the bill and instructed the executive committee to cooperate with other agencies in perfecting the measure and aiding in its passage.

Various measures relative to military instruction in the land-grant colleges were referred to the executive committee for consideration. An engineering division was established in the college sectional meeting with provision for either separate or joint programs.

Officers for the ensuing year were chosen as follows: President, E. A. Bryan, of Washington; Vice-presidents, J. H. Worst, of North Dakota, T. F. Hunt, of California, C. D. Woods, of Maine, P. H. Rolfs, of Florida, and C. A. Lory, of Colorado; Secretary-treasurer, J. L. Hills, of Vermont; Bibliographer, A. C. True, of Washington, D. C.; Executive Committee, W. O. Thompson, of Ohio, chairman, H. J. Waters, of Kansas, Brown Ayres, of Tennessee, W. H. Jordan, of New York, and H. L. Russell, of Wisconsin.

The time and place of the next meeting were left as usual with the executive committee.

Afternoon sessions were held by the sections on college work and administration, experiment station work and extension work. In the college section, the initial paper was on "The Relation of the Agricultural College to Instruction in Agriculture and Home Economics in Secondary and Rural Schools," and "What the College Can Do to Promote General Rural School Improvement." In this paper, President E. T. Fairchild, of New

Hampshire, suggested that the agricultural colleges aid in securing the consolidation of scattered rural schools and their more liberal financial support, undertake a propaganda for rural high schools within the states and teachers' training classes in these schools, and favor a law requiring the teaching of agriculture in elementary schools and the training of teachers in the elements of agriculture. President Vincent, of Minnesota, also advocated summer sessions at the colleges for training rural teachers.

President D. H. Hill, of North Carolina, in a paper entitled "Some Changed Attitudes" called attention to the increasing tendency to magnify the educational value of utilitarian subjects. Inasmuch as the mere training of experts will not make leaders of men, he advocated the retention of some subjects which turn men's minds away from the purely materialistic point of view.

The cost of instruction in agricultural colleges and the relation of salaries in the division of agriculture to those of other divisions in the agricultural colleges and universities was discussed by President C. A. Lory, of Colorado. This paper described and illustrated by means of charts a system of cost keeping based on the units of semester credit, student semester credit and student recitation hour, the last named being found the most satisfactory.

President H. J. Waters, of Kansas, was elected chairman of this section for the ensuing year and President W. M. Riggs, of South Carolina, secretary.

In the experiment station section, under the topic of "Meat Production as a Factor in the Progress of Agriculture in the United States," George M. Rommel, of the U. S. Department of Agriculture, presented for Dr. A. D. Melvin and himself a paper on "Meat Production in the Argentine and Its Effect on the Industry in the United States." Although nearly 140,000,000 pounds of beef were imported from Argentina during the last year, they believed that killings are about as great as breeding conditions will warrant, and therefore need cause no serious concern to American producers. On the other hand, it was thought that Argentina offers a possible market for breeding stock deserving of increased attention. Dean F. B. Mumford discussed "Meat Production on the High-priced Corn Lands," concluding that the methods which are likely to result in decreasing the cost of meat production and thereby making it possible for the farmers of the corn belt region to produce meat animals on high priced land are to be found in developing unimproved areas of land for grazing purposes; by utilizing the by-products of the farm, particularly coarse roughage such as stover, straw and cheap hay; by the general adoption of the silo as a means of preserving corn and other crops; by feeding more sheep and hogs because of their well-known efficiency in the utilization of feed-stuffs; and lastly, by the selection of more efficient meat animals. "The Possibilities and Methods of Meat Production in the South" were summarized by D. T. Gray, of North Carolina, who pointed out the advantages of this region in cheap lands and labor, mild climate and long growing season, and comparative nearness to markets, and believed that success was to be expected upon adapting the industry closely to southern conditions as to feeds, buildings, etc.

Dr. E. W. Allen, of the Office of Experiment Stations, explained the administration of experiment station work by projects. The project properly defined and limited has been found a convenient unit in planning, financing and supervising station work. It provides a record of the stations' activities, assists in defining the scope of this work and tends toward general economy and efficiency. The discussion following brought out a general concurrence as to the merits of the project system. A paper entitled "How Can American Agricultural Experiment Stations Gain Higher Standing as Institutions for Scientific Research," was read by Director S. B. Doten, of Nevada. The selection of high-grade men and the careful conserving of their time, and the provision of a scientific atmosphere were among the means suggested.

The section officers elected for the ensuing

year are Dean E. A. Burnett, of Nebraska, chairman; Director W. R. Dodson, of Louisiana, secretary; and W. H. Beal, of the Office of Experiment Stations, recording secretary.

The section on extension work held a joint session with the American Association of Farmers' Institute Workers, at which Dr. A. C. True took up the question of the use of the Smith-Lever fund for farmers' institutes as a phase of extension work. In this he drew attention to the strictly educational character of the extension work contemplated by the act and the great stress laid on practical demonstrations. The farmers' institutes, therefore, come within the provisions of the law only so far as they may be agencies through which the colleges can carry on work of this type. Where the institute system is directly connected with the colleges it is believed that they may be easily modified and restricted in scope so as to give them a distinctive place in the extension system. In states where the institutes are under the direction of other agencies, their maintenance apparently does not come within the provisions of the law, though there may be cooperation and participation by the college staffs. The eventual establishment of a county agent system will also affect the situation. Conditions as to farmers' institute administration at present vary so widely in different states that apparently the first need is a standardization of the institute.

The relation of farmers' institutes to organized extension agencies was also discussed by G. I. Christie, of Indiana. He believed that the institute is fulfilling a practical need but should be correlated with other extension work and brought under the supervision of the colleges.

As an example of a model farmers' institute address, Director C. E. Thorne, of Ohio, gave a paper on "Maintaining Crop Production." Former Dean L. H. Bailey, of Cornell University, closed the joint session with an address on "The Present Responsibility of the Rural People." This had special reference to the conditions brought about by the European war and emphasized the political responsibility of rural people in the progress of the nation.

The extension section also took up the problem of placing county agents in effective touch with farmers. C. B. Smith, of the States Relations Committee, indicated as among the essentials the employment of a well-trained representative, the making of a complete survey of the agricultural conditions, and the securing of the cooperation of the existing organizations, working through groups wherever possible. C. R. Titlow, of West Virginia, also advocated the utilizing of existing organizations, both official and non-official, and presented a chart showing graphically the correlation of the various agencies.

C. D. Jarvis, of Connecticut, discussed the planning of extension work by means of definite written projects, favoring in addition to the federal requirements a seasonal schedule for workers. K. L. Hatch, of Wisconsin, submitted a report from the committee on the training of extension teachers, advocating the provision of technical training along the special line of prospective extension work and instruction in the art of teaching. He suggested that the time necessary for this training might be secured by eliminating requirements of foreign languages and mathematics. Teachers of approved ability in secondary agricultural schools were suggested as a promising source of supply for extension work. The officers elected for the ensuing year were R. D. Hetzel, of Oregon, chairman; C. R. Titlow, secretary, and John Hamilton, of Pennsylvania, recording secretary.

Howard L. Knight

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Philadelphia, during convocation week, beginning on December 28, 1914:

American Association for the Advancement of Science.—President, Dr. Charles W. Eliot, Harvard University; retiring president, Professor Edmund B. Wilson, Columbia University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary,

Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.; secretary of the council, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.

Section A—Mathematics and Astronomy.—Vice-president, Professor Henry S. White, Vassar College; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Anthony Zeleny, University of Minnesota; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Provost Edgar F. Smith, University of Pennsylvania; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Albert Noble, New York; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor U. S. Grant, Northwestern University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor Frank R. Lillie, University of Chicago; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. G. P. Clinton, Connecticut Agricultural Experiment Station; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Dr. Clark Wissler, American Museum of Natural History; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Richard Mills Pearce, University of Pennsylvania; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Professor Paul H. Hanus, Harvard University; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor L. H. Bailey, Cornell University; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

The American Physical Society.—Convocation Week. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 29. President, Professor C. R. Mann, Carnegie Foundation, New York City; secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 31. President, Professor Samuel F. Clarke, Williams College; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 29–31. President, Professor C. E. McClung, University of Pennsylvania; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Society of American Bacteriologists.—December 29–31. President, Professor Charles E. Marshall, Massachusetts Agricultural College; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

The Entomological Society of America.—December 31–January 1. President, Professor Philip P. Calvert, University of Pennsylvania; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 28–31. President, Professor H. T. Fernald, Amherst College; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Geological Society of America.—December 29–31. President, Dr. George F. Becker, U. S. Geological Survey, Washington, D. C.; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Paleontological Society.—December 29–31. President, Dr. Henry F. Osborn, American Museum of Natural History, New York City; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Botanical Society of America.—December 29–January 1. President, Dr. A. S. Hitchcock, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 29–January 1. President, Dr. Haven Metcalf, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Fern Society.—December 28–29. Secretary, Charles A. Weatherby, 749 Main St., East Hartford, Conn.

Sullivant Moss Society.—December 30. Secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

American Nature-Study Society.—December 30–31. Secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Alpine Club.—January 2. Secretary, Howard Palmer, New London, Conn.

American Association of Official Horticultural Inspectors.—December 29–30. Chairman, Dr. W. E. Britton, New Haven; secretary, Professor J. G. Saunders, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Charles Brookover, Little Rock, Ark.; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

The American Anthropological Association.—December 28–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor R. S. Woodworth, Columbia University; secretary, Professor R. M. Ogden, University of Tennessee, Nashville, Tenn.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The American Association for Labor Legislation.—December 28–29. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

Society of Sigma XI.—December 29. President, Professor J. McKeen Cattell, Columbia University; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

ST. LOUIS

The American Physiological Society.—December 28–30. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor Graham Lusk, Cornell University Medical School; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 28–30. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society for Experimental Pathology.—December 28–30. President, Professor Richard M. Pearce, University of Pennsylvania; secretary, Dr. George L. Whipple, San Francisco, Cal.

CHICAGO

American Mathematical Society.—December 28–29. President, Professor E. B. Van Vleck, University of Wisconsin.

The Association of American Geographers.—December 29–31. President, Professor A. P. Brigham, Colgate University; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

The American Philosophical Association.—December 28–30. President, Professor J. H. Tufts, University of Chicago; secretary, Professor E. G. Spaulding, Princeton, N. J.

PRINCETON

The American Economic Association.—December 28–31. President, Professor John D. Gray, University of Minnesota; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW YORK CITY

The American Mathematical Society.—January 1–2. President, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

SCIENCE

FRIDAY, DECEMBER 18, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VALUE OF RESEARCH TO INDUSTRY[1]

THE large chemical industries and, in fact, all branches of chemical technology have been immensely developed during the nineteenth and twentieth centuries, and the achievements of chemistry in the arts and industries have been stupendous and varied. In particular, industrial research—definable as "the catalysis of raw materials by brains"—has been and is being increasingly fostered by chemical manufacturers, and this has led to the accruement of important novelties and improvements.

Many excellent résumés of the development of industrial chemistry during the modern chemical period have appeared in the literature. I shall only remind you that these indicate how industrial chemistry has been elevated by a continuous infusion of scientific spirit, and that manufacturing, once entirely a matter of empirical judgment and individual skill, is more and more becoming a system of scientific processes. Quantitative measurements are replacing guesswork, and thus waste is diminished and economy of production insured. In the United States, several decades ago, few industrial establishments furnished regular employment to chemists, but now American manufacturers are becoming more and more appreciative of scientific research, and the results so far obtained have resulted in far-reaching improvements. In the production of a metal from its ores, or of benzene derivatives from coal-tar, it is chemistry that points

[1] An address delivered, by invitation, at the inaugural meeting of the session of the Royal Canadian Institute, Toronto, November 7, 1914.

the way, and the more complex the problem the greater the dependence. In devising new processes and in the discovery of new and useful products, chemistry is again the pathfinder. The community is apt to overlook the extent and diversity of the services rendered by the chemist, because of the quiet and unobtrusive way in which the work is carried out.

The measure of a country's appreciation of the value of chemistry in its material development and the extent to which it utilizes this science in its industries, generally measure quite accurately the industrial progress and prosperity of that country. In no other country in the world has the value of chemistry to industry been so thoroughly understood and appreciated as in Germany, and in no other country of similar size and natural endowment have such remarkable advances in industrial development been recorded, and this, too, with steadily increasing economy in the utilization of the natural resources.

THE CHEMICAL INDUSTRIES OF GERMANY

The history of the great firm of Farbwerke vorm. Meister Lucius und Brüning at Höchst a/M., Germany, serves as an admirably typical record of the development of German chemical industry.

In 1862, two chemists and two merchants organized a firm for the manufacture of tar colors, and the plant was started the following year with five workmen, one clerk, and one chemist. One boiler of 3-horse-power supplied the power. Fuchsin, anilin blue, alkali blue, aldehyde green, methyl violet, methyl green and malachite green were the first products. In 1869, the manufacture of alizarine was taken up. In 1878, new buildings were erected for the manufacture of azo-dyes, and two years later the firm was formed into an Actien-Gesellschaft. In 1883, the manufacture of pharmaceutical preparations were started with antipyrine; in 1892, Koch's tuberculin and Behring's diphtheria serum were prepared and marketed; and in 1898 the manufacture of synthetic indigo was begun. The number of types and colors manufactured twenty-five years ago amounted to 1,750; in 1913, about 11,000 were manufactured. In 1888, the steam engines had a total horse-power of 1840; in 1913, 30,000 horse-power were required. In 1888, 1,860 workmen and *57 chemists* were employed; in 1912, 7,680 workmen, 374 foremen, *307 chemists* and 74 other technical men were on the payroll. In 1912, 8.6 million marks were paid in wages and 5.2 million marks in salaries and bonuses.

Since Wallach began his investigation of essential oils and terpenes in 1884, the manufacture of perfumes in Germany has grown continuously. In 1895, synthetic neroli oil was prepared; in 1896, oils of jasmine and hyacinth blossoms, and, in 1908, the essential oils of lily of the valley, were synthesized. In the explosives industry the chief efforts have been directed to the manufacture of safe products. While in 1890, 4,938 tons of dynamite were produced and only an insignificant quantity of safety explosives, in 1909 the production of safety explosives amounted to 10,000 tons as compared with 8,000 tons of dynamite. The great development of the German dyestuffs industry led to developments in many other branches, especially in the sulphuric acid, chlorine, tar-oils and nitric-acid industries. The development of the cyanide process for the extraction of gold also led to the introduction of a new technical process of manufacturing synthetic indigo, based on the use of sodium amide in the alkali fusion of phenylglycin. In 1913, the selling value of the synthetic indigo on the world market amounted to

nearly $2,500,000. The demand of the dyestuffs works for coal-tar products also led to the great development in the recovery of by-products in coke manufacture. The recovery of ammonia as ammonium sulphate, a valuable fertilizing material, has grown rapidly in Germany.

The purely inorganic chemical works in Germany have been in a different position as compared with the large color works, which, with their large and excellent scientific and commercial organization, as well as their splendid financial position, represent enormous powers. The German color works long ago ceased to purchase the inorganic products they required. In 1913, they worked their own mines, made all inorganic and intermediate products themselves, not only for their own requirements, but also for sale, and controlled every branch of chemical industry. The great advance of these large concerns made it very difficult for the inorganic works to take up new manufactures to compensate for the continued falling-off in the profits on heavy chemicals.

Much is to be learned from a study of the history of German technology. We find, for instance, that the progress of industrial chemistry, especially in its synthetic branches, has lagged in the United States because the United States corporation and patent laws are unfavorable (in Germany a patent must be worked or forfeited) and because there is no large supply of cheap researchers. German conditions in these respects have been the direct causes for the German development. However, with proper legislation, the chemical industry will develop in the United States, at least to the same extent as in Germany, for American engineering ingenuity will serve to counterbalance the advantage of cheap labor; and the same applies to Canada, whose engineers have demonstrated skill and resource in many developments of importance to the Dominion.

Like Canada, the United States has unnecessarily imported too much. Given proper conditions, American industrialists can take care of a large amount of goods now being imported, and in some cases produce them here. In other cases, they could even become exporters of commodities now imported. To accomplish this, however, a large amount of research will be necessary, and, in general, considerable investments will have to be made.

THE CHEMICAL INDUSTRIES OF SWEDEN

Since most of the rivers of Canada possess waterfalls on their course, they must become increasingly important as sources of power, the basis of industry. Your swift-flowing streams, capable of supplying almost unlimited power, remind one of those which are the boast of Sweden and Norway; and like these countries, Canada has not only waterfalls, but she has many lakes, which will serve some day as large natural reservoirs for conducting the water to the power stations. It is appropriate, therefore, that brief reference be made to the chemical industries of Scandinavia.

Sweden is a land in which chemistry has played an important rôle from an early date. No less than twenty of the known chemical elements have been discovered by Swedes, and we are all familiar with the pioneer work of Scheele and Berzelius during the constructive period of chemistry.

Sweden owes to three factors its past and present position in industrial chemistry: an abundantly diversified mineral wealth; forests of enormous extent; and abundant water power. Its metal products are of notably high quality; the manufacture of cellulose in its varied forms constitutes an enormous industry; and the electrochemical industries have availed themselves of

the vast water power. Research is constantly in progress, and the results of the Swedish investigations in the electric smelting of iron ores have indicated much for a better utilization of the iron deposits in certain parts of the United States where conditions are not unlike those existing in Sweden.

THE CHEMICAL INDUSTRIES OF NORWAY

There are several features worthy of careful study in connection with the chemical industries of Norway. First is the very systematic and exhaustive manner in which the abundant water power of the country has been regulated, stored up, and pressed into the service of the constantly growing group of electrochemical industries. The highest engineering and chemical talent of Norway is patriotically enlisted in this cause, and already the road is constructed for little Norway to assume an industrial position commensurate with its geographical size and maritime facilities.

In the field of industrial organic chemistry, Norway has also shown her ability to develop an industry—the manufacture of oxalic acid. This is a branch of manufacture which has never been developed in North America, and, as there is only one plant producing oxalic acid in the United States, comparatively enormous amounts of money have normally been expended annually in the purchase of this commodity in Norway and Germany.

While the climate is severe, coal is lacking, the mineral deposits are not easily accessible, and the conditions of life are comparatively hard, the Norwegians have brought certain chemical industries to the fore. In the development of these, chemical research has had a prominent part.

THE CHEMICAL INDUSTRIES OF HOLLAND

The Netherlands offers a most interesting example of what can be accomplished in building up diversified branches of the chemical industries when there is an almost complete dependence upon foreign fuel and raw material. The evolution of the manufacture of starch, of mineral pigments, of matches, and fertilizers, as well as the industries connected with the oils and fats, are most instructive in this connection.

Providing the people of Holland remain free from military burdens, it may be predicted that the exceptionally high degree of thrift, intelligence and enterprise characterizing the Dutch will enable them to accomplish the enlargement of the field of chemical industry and to free the country from dependence upon foreign sources of supply of finished products.

THE CHEMICAL INDUSTRIES OF BELGIUM

Prior to the present war, Belgium was regarded from the standpoint of the technologist as offering a most instructive example of what can be done in a small country in the healthy development of a large group of closely allied industries. All the chemical branches dependent to a greater or less extent upon the natural products of the land had been brought to a high state of perfection. In addition, numerous chemical industries utilizing raw materials of foreign origin had been called into existence. Then, too, the ability to capture, in various directions, foreign markets for different chemical products had been revealed to an astonishing degree.

The Belgian chemists of the next decade will once more be obliged to concentrate their endeavors in building up the industries for which the little kingdom was so worthily famous—the production of staple articles of value. In this line they will, no doubt, show that high degree of inventive skill, capacity for organization and commercial acuteness which has always characterized the Belgian technologist.

THE INDUSTRIAL CHEMISTRY OF TO-DAY

The picture that technical chemistry presents to-day is quite different from that of thirty years ago. There is more brilliancy around the accomplishment of the organic than of the inorganic industries. The replacement of natural dyes by the products of coal tar, the extension of our medical resources by the manufacture of synthetic medicines, has gone far to extend the appreciation of chemical work and to produce the general conviction that chemistry is an inexhaustible field of economic possibilities. Indeed, one natural product after another falls into the domain of chemical synthesis, and chemistry is becoming the important factor in the economy of the tropical products which are used for industrial purposes. As soon as the price of such a product exceeds a certain limit, organic chemistry enters the field and synthesizes it. Tanning materials are in a struggle with the condensation products of formaldehyde and phenolsulfonic acids. Camphor could maintain its position only by large price reduction, and the prospect of synthetic rubber has held down the would-be inflated prices of the natural product. The basis of this marked development in organic chemical industries is the combined working of science and technology. The success of this intermingling is so obvious that I need not dwell on the point.

In the domain of inorganic technical chemistry things are somewhat different. Here, too, a great change has taken place. The historical sulphuric acid and soda processes have lost much ground to the ammonia-soda and electrolytic processes, and to the contact process. New branches of industries have taken root and grown up. In this field, however, the connection between scientific and technical progress is neither so obvious nor so well recognized as in the realm of industrial organic chemistry. The reason is that the advance in inorganic science, during the last decade or two, has resulted less in the discovery of new facts which had direct technical applications, than in the elucidation and working out of new theoretical views. In fact, the introduction of physical laws and physical methods into the working sphere of inorganic chemistry has led to the greatest scientific progress. The invasion of physics into chemistry has produced the splendid development of physical chemistry, the basis of which is the second law of thermodynamics, the phase rule, and the theory of electrolytic dissociation. The introduction of the electroscope into chemical analysis has opened up the new chemical world of radioactivity. Now inorganic chemical industries can gain almost as much by regarding their problems from a physical point of view as organic industries do by the application of structural considerations.

THE VALUE OF PHYSICO-CHEMICAL RESEARCH

Owing to the progress of physical chemistry, based largely upon thermodynamics and including the accurate quantitative study of the conditions determining the reactivity of substances and the velocity of chemical change, chemistry has, indeed, undergone revolutionizing changes during the past twenty-five years. The study of the behavior of catalysis comes well within the province of physical chemistry. As examples of industrial processes based upon catalytic action, I shall mention in passing the Deacon chlorine process, the contact sulphuric process, the hydrogenation of unsaturated fatty acids and their esters, the synthesis of ammonia from its elements, the oxidation of naphthalene in the production of synthetic indigo, and certain methods of surface combustion.

Fermentation industries and the whole field of agriculture depend upon physical chemistry for their further progress and development; for enzymes are essentially

catalysts and the stimulating action of small quantities of inorganic compounds on the growth of plants has been demonstrated. For instance, very small additions of manganese or zinc, or mixtures thereof, increase the yield of plant culture.

In this connection I may refer to the application of the phase rule by van't Hoff to the better utilization of the Strassfurt salt deposits, and to electrochemistry, photochemistry, and to the chemistry of colloids.

The successful solution of the problem of the oxidation of atmospheric nitrogen, the production of ammonia from its elements, and the manufacture of sulphuric acid by the contact process, were only made possible by the knowledge of the principles and methods of chemical dynamics and thermodynamics.

Further, the teachings of physical chemistry have led to the study of the conditions of absorption of drugs by the various cells and tissue juices of the body, of the part played therein by osmosis, by electrolytic dissociation, by mass, and especially by the colloidal character of the substances concerned in metabolism. Such study associated with biological chemistry has pointed the way to new methods of research which promise well for a fuller understanding of the complexities of the processes that are comprised in the physiological action for drugs.

Despite the mass of material that has thus been accumulated, a scientific basis for the preparation of physiologically active compounds is but in its infancy. The possibility of precalculating the action of a drug from its chemical structure is as yet developed to but a limited extent, as has been repeatedly brought home during recent years by the discovery of new groups of compounds possessing valuable therapeutic properties, the physiological action of which was in no way anticipated. Indeed, the recognition of the therapeutic value of some of the earlier synthetic drugs was effected, as Keane has indicated, rather in accord with Priestley's belief that all discoveries are made by chance, and has been extended with some reminiscence of his view that scientific investigation was to be "compared to a hound, wildly running after. and here and there chancing on game." The hypnotic property of sulphonal was a chance discovery; the physiological action of antipyrine was initially examined on account of its supposed relation in chemical structure to kairine and allied febrifuges, which was subsequently proved to be incorrect; and the purgative properties of phenolphthalein became known from the results that followed its use to earmark, for administrative purposes, a certain kind of wine in Austria-Hungary. The commercial success of antipyrine—the profits in one year from its manufacture before the expiration of the patent are said to have reached $300,000—was followed by a hunt for further "game" and many a compound, such as acetanilide, has been called from the seclusion of chemical museums for the examination of its physiological properties.

The recognition of the therapeutic value of such substances has been followed by inquiry into the relation of their chemical structure and physiological action, with the result that the study of this relation has since become more ordered and systematic.

GEOCHEMICAL RESEARCH

A study of the manner in which certain minerals are usually found associated together in nature, commonly those which are isomorphous or which contain the same group of elements, but very often of entirely different mineralized and chemical character, is of particular importance to the commercial man, and should be of great

assistance to those chemists and physicists who study the genesis of minerals and "elements" and the so-called degradation of the latter. Just as the periodic law of Newlands and Mendeléeff was evolved from the tabular collating of chemical and physical data, and was found capable of prophetic use, so one may learn and predict much from a study of the known associations of minerals, and particularly those of the rare metals. One has the advantage of knowing that minerals have been produced under natural conditions where no mistakes or errors of manipulation can have occurred and where no difficulties due to want of time, material, or facilities for experimenting existed; in other words, where the personal factor was absolutely non-existent.

Probably the most promising field for research exists in the oldest plutonic rocks, and particularly in such pegmatites and other extremely old granitic and other rocks as have been subjugated, at great depth and pressure and at high temperatures, to the action of intruded flows of fused mineral matter from still deeper-seated sources, or of vaporized mineral matter of similar origin. Such rocks exist in many parts of the world, but the pegmatites of Norway, the old granites of Greenland, and many of the old but less highly crystalline tin-bearing deposits of Cornwall, may be instanced as likely to throw light on the origin of certain metals, and especially of those at the "heavy" and "light" ends of the periodic table. Perhaps

> There is in this business more than nature
> Was ever conduct of.

It is probable that some of the missing heavy elements near the uranium end of the table may be found in such rocks, and that certain light elements, for which room may have to be made in the table, may also be discovered.

The comprehensive investigations in progress at the geophysical laboratory of the Carnegie Institution illustrate the change now occurring in geochemical research.

THE VALUE OF RESEARCH IN METALLURGY

To the valuable properties of the many alloys of iron now manufactured, from carbon steel to the complex alloy known as high-speed tool steel, which contains no less than five different elements apart from the iron itself, is to be attributed the great progress which has been made, whether in the arts of peace or in war. There is one simple concrete instance—the modern automobile. Eliminate the alloy steels used in its construction, and it could no longer be produced. The combination of lightness and strength necessary in such modern products is only made possible by the use of special alloy steels.

While the progress made in alloy steels since Hadfield's first researches in 1882 and onwards has been wonderful, indeed, the field for research is still an immense one, full of difficulties, disputed points, and important problems. It is true that there may not be at the present time room for such abnormal discoveries in ferrous metallurgy as in the past, but investigators are quietly and steadily augmenting our knowledge of iron and its alloys, and the value of such research work is generally recognized.

It remains to mention in this connection that the science of metallography, which has so materially aided the progress of metallurgy, has been developed by the assistance of the phase rule.

Research work of an elaborate nature is constantly being conducted by several manufacturers, especially at Homestead, Pa., by the United States Steel Corporation, which has to date expended over $800,000 in investigations on the electro-

thermic production of steel alone. However, metallurgical research laboratories are still comparatively uncommon. Very few iron furnaces or smelting plants are without a control laboratory, which has come about notwithstanding the opposition of "practical men," and the research laboratory will eventually win a similar victory.

The great problems at present in the metallurgy of zinc are in the concentration of the ore and in the treatment of flotation concentrate. The latter produces the troubles that fine ore always does; it is difficult to roast, and the distillation of it is attended with troubles.

Viewing the present status of the practise in zinc smelting, one is impressed by the high extraction results, the low fuel consumption made possible by regenerative gas-firing, and the reduction of labor involved in the art.

In copper metallurgy, the leaching of copper ores and electrolytic deposition for precipitating are receiving increased attention. In electrolytic copper refining, promising progress has been made in the treatment of anode slimes; and more attention is being paid to the recovery of byproducts, new uses for two of which, selenium and tellurium, are required.

COOPERATION BETWEEN SCIENCE AND INDUSTRY

While those engaged in a profession which has so many ramifications as has chemistry in its numerously various applications to all modern activities, must cooperate to effect advancement, before such cooperation can be effective, there must be a mutual understanding between chemists as a profession and industrialists. Many American chemical manufacturers still follow rule-of-thumb methods without having any idea of the underlying principles which are immutable. These manufacturers must be induced to recognize the actuality of such principles and to realize fully that an actual comprehension thereof is necessary for the attainment of that measure of success necessary to maintain uniform quality and maximum output of product.

In this connection, I may say that the system of practical cooperation between industry and learning, founded by the late Dr. Robert Kennedy Duncan, has had eight years of trial. The outcome of my eminent predecessor's labors, The Mellon Institute, through its industrial fellowship system, represents a happy and successful alliance between science and industry, for a valuable and permanent relation has been established by the solution, at the institute, of many important manufacturing problems.

THE METHODS OF ATTACKING INDUSTRIAL PROBLEMS

When a chemical industry has problems requiring solution, these problems can be attacked either inside or outside of the plant. If the policy of the management is that all chemical problems are to be investigated only within the establishment, a research laboratory or at least a research chemist must be provided for the plant or for the company. At present, in the United States, probably not more than 100 manufacturing establishments have research laboratories or employ research chemists, although at least five companies are spending over $100,000 per year in research. In Germany, and perhaps also in England, such research laboratories in connection with chemical industries have been much more common. The great laboratories of the Badische Anilin und Soda Fabrik and of the Elberfeld Company are striking examples of the importance attached to such research work in Germany, and it would

be difficult to adduce any stronger argument in support of its value than the marvelous achievements of these great firms.

An unfortunately frequent difficulty encountered in the employment of research chemists, or in the establishment of a research laboratory, is that many manufacturers do not appear to grasp the need or importance of such work, or know how to treat the men in charge so as to secure the best results. The industrialist may not even fully understand just what is the cause of his manufacturing losses or to whom to turn for aid. If he eventually engages a chemist, he is sometimes likely to regard him as a sort of master of mysteries who should be able to accomplish wonders, and, if he can not see definite results in the course of a few months, is occasionally apt to consider the investment a bad one and to regard chemists, as a class, as a useless lot. It has not been unusual for the chemist to be told to remain in his laboratory, and not to go in or about the works, and he must also face the natural opposition of workmen to any innovations, and reckon with the jealousies of foremen and of various officials.

From the standpoint of the manufacturer, one decided advantage of the policy of having all problems worked out within the plant is that the results secured are not divulged, but are stored away in the laboratory archives and become part of the assets and working capital of the corporation which has paid for them; and it is usually not until patent applications are filed that this knowledge, generally only partially and imperfectly, becomes publicly known. When it is not deemed necessary to take out patents, such knowledge is often permanently buried.

In this matter of the dissemination of knowledge concerning chemical practise, it must be evident to all that there is but little cooperation between the manufacturers and the universities. Chemical manufacturers have been quite naturally opposed to publishing any discoveries made in their plants, since "knowledge is power" in manufacturing as elsewhere, and new knowledge gained in the laboratories of the company may often very properly be regarded as among the most valuable assets of the concern. The universities and the scientific societies, on the other hand, exist for the diffusion of knowledge, and from their standpoint the great disadvantage of the above policy is this concealment of knowledge, for it results in a serious retardation of the general growth and development of the science in its broader aspects, and renders it much more difficult for the universities to train men properly for such industries, since all text-books and general knowledge available would in all probability be far behind the actual manufacturing practise. Fortunately, the policy of industrial secrecy is becoming more generally regarded in the light of reason, and there is a growing inclination among manufacturers to disclose the details of investigations, which, according to tradition, would be carefully guarded. These manufacturers appreciate the facts that public interest in chemical achievements is stimulating to further fruitful research, that helpful suggestions and information may come from other investigators upon the publication of any results, and that the exchange of knowledge prevents many costly repetitions.

INDUSTRIAL FELLOWSHIPS

If the manufacturer elects to refer his problem to the university or technical school, such reference may take the form of an industrial fellowship and much has been and may be said in favor of these fellowships. They allow the donor to keep secret for three years the results secured, after

which they may be published. They also secure to him patent rights. They give highly specialized training to properly qualified men, and often secure for them permanent positions and shares in the profits of their discoveries. It should be obvious at the outset that a fellowship of this character can be successful only when there are close confidential relations obtaining between the manufacturer and the officer in charge of the research; for no such coöperation can be really effective unless based upon a thorough mutual familiarity with the conditions and an abiding faith in the integrity and sincerity of purpose of each other. It is likely to prove a poor investment for a manufacturer to seek the aid of an investigator if he is unwilling to take such expert into his confidence and to familiarize him with all the local and other factors which enter into the problem from a manufacturing standpoint.

According to the system of industrial research in operation at The Mellon Institute of Industrial Research of the University of Pittsburgh,[2] a manufacturer having a problem requiring solution may become the donor of a fellowship: said manufacturer provides the salary of the fellow selected to conduct the investigation desired, the institute furnishing such facilities as are necessary for the conduct of the work.

The money paid in to found a fellowship is paid over by the institute in salary to the investigator doing the work. In every case, this researcher is most carefully selected for the problem in hand. The institute supplies free laboratory space and the use of all ordinary chemicals and equipment. The fellow who is studying the problem works under the immediate supervision of men who are thoroughly trained and experienced in conducting industrial research.

At the present time, The Mellon Institute, which, while an integral part of the University of Pittsburgh, has its own endowment, is expending over $150,000 annually for salaries and maintenance. A manufacturer secures for a small expenditure—just sufficient to pay the salary of the chemist engaged on the investigation—all the benefits of an organization of this size, and many have availed themselves of the advantages.

Each fellow has the benefit of the institute's very excellent apparatus, chemical and library equipment—facilities which are so essential in modern research; and because of these opportunities and that of being able to pursue post-graduate work for a higher degree, it has been demonstrated that a higher type of research chemist can be obtained by the institute for a certain remuneration than can be generally secured by manufacturers.

There is a scarcity of men gifted with the genius for research, and it requires much experience in selecting suitable men and in training them to the desirable degree of efficiency, after having determined the special qualities required. Important qualifications in industrial researches are keenness, inspiration and confidence; these are often unconsidered by manufacturers, who, in endeavoring to select a research chemist, are likely to regard every chemist as a qualified scientific scout.

All researches conducted at The Mellon Institute are surrounded with the necessary secrecy, and any and all discoveries made by the fellow during the term of his fellowship become the property of the donor.

It is well said in the *Reports* of the Twelfth Census of the United States that

[2] On the progress which has been made in industrial fellowships, see R. F. Bacon, *J. Frankl. Inst.*, November, 1914, 623.

probably no science has done so much as chemistry in revealing the hidden possibilities of the wastes and by-products in manufactures.

This science has been the most fruitful agent in the conversion of the refuse of manufacturing operations into products of industrial value. . . . Chemistry is the intelligence department of industry.

Yet we are often uninformed concerning the character and amount of the by-products going to waste in our immediate neighborhoods, a careful study of which might lead not only to financial reward for the manufacturer as well as for ourselves, but might also prevent much of the present pollution of our streams and of the air we breathe.

It is not only very desirable, but will soon become really necessary for manufacturers to avail themselves more freely of the assistance of the experts in universities, technical schools and scientific institutes.

THE FUTURE OF RESEARCH IN CANADA

With a strong and prosperous nation to the south, expert in manufacturing operations and constantly endeavoring seriously to gain markets for its surplus production, Canada has developed less rapidly from an industrial viewpoint than if she occupied a more isolated position geographically. European and American products have long been familiar to the Canadian people, and the manufacturers of the Dominion have had an arduous struggle in establishing their wares. But this time is past. Since 1910, all over Canada, new factories have been erected, new products are being manufactured, and new plans for the future are being considered.

With her diversified and abundant mineral resources, her extensive forests and her great power sources, Canada has indeed wonderful industrial prospects. Noteworthily helpful work in the opening-up of various fields has been done by your Department of Mines, whose distinguished division Directors, Dr. Eugene Haanel, of the Mines Branch, and Dr. R. W. Brock, of the Geological Survey, have been pioneers in your industrial development; but as your mineral, wood and water-power wealth become more and more apparent, just so much more will the need for and value of industrial research become apparent to your manufacturers. As in other countries, chemistry will be the pathfinder.

Canada is but at the adolescent period in her industrial life. Your patriotism need not therefore be shocked by apparently

> Nourishing a youth sublime
> With the fairy tales of science.

Many of the natural secrets of your vast country have been gained, laboriously wrought for, but rich rewards await your coming generations who inherit the knowledge gained by an awakened conscience of research.

RAYMOND F. BACON

UNIVERSITY OF PITTSBURGH

OCEANOGRAPHIC CRUISE OF THE U. S. BUREAU OF FISHERIES SCHOONER "GRAMPUS," JULY AND AUGUST, 1914

DURING the past summer the fisheries schooner *Grampus* has continued the oceanographic work of 1912 and 1913,[1] in my charge, with Mr. W. W. Welsh as assistant. The general problem laid out for the *Grampus* cruises of the past three years has been the study of currents, salinities, temperatures and plankton of the coastal waters off our eastern seaboard. In 1912 the work was confined to the Gulf of Maine; in 1913 it extended over the whole

[1] H. B. Bigelow, "Oceanographic Cruises of the U. S. Fisheries Schooner *Grampus*, 1912–13," SCIENCE, N. S., Vol. 38, No. 982, pp. 599–601, October 24, 1913; "Explorations in the Gulf of Maine, July and August, 1912, by the U. S. Fisheries Schooner *Grampus*. Oceanography and Notes on the Plankton," *Bull. M. C. Z.*, Vol. 58, pp. 31–147, 9 pls., 1914.

breadth of the continental shelf between Cape Cod and Chesapeake Bay, with a repetition of the Gulf of Maine stations; and for 1914 we planned to continue our survey eastward from Cape Cod, as far as Cape Breton and Cabot Straits, to connect with the observations taken by the U. S. revenue cutter *Seneca* during the preceding spring. Special attention was to be devoted to George's Bank, important oceanographically because of its position as a rim between the cold water of the Gulf of Maine and the Gulf Stream; to the effect of St. Lawrence water on the physical characters of the coast water in general, and on the Gulf Stream; and to the possible influence of the Labrador Current on our coasts. Experience has shown that the coastal water, bounded as it is by the coast on one hand and the Gulf Stream on the other, is best studied by successive sections normal to the coast; and our stations were located with this end in view. We were able to carry out this program as far as Halifax. But the European war forced us to relinquish the stations further east; and the time thus released was devoted to repeating our Gulf of Maine stations, and to running a section from Marthas Vineyard to the Gulf Stream for comparison with the preceding year.

The general program of work for each station consisted of serial temperatures and water samples, at sufficiently small vertical intervals to afford satisfactory salinity and temperature sections (3 to 7 according to the depth); a vertical haul with the Hensen quantitative net, especially instructive for copepods, less so for larger and more active organisms; surface hauls with the fine (No. 20) and coarse (No. 5) silk nets; and hauls at intermediate depths with one or more of the large nets, according to depth. When two were used they were attached simultaneously to the wire rope, the Helgoland net usually at the lower, the "Michael Sars" net at the higher level. In addition, the surface temperature was taken hourly throughout the cruise; and the color of the sea frequently recorded by the Forel scale. Current measurements occupy so much time that we obtained only one complete record of an entire tide from the ship at anchor.

Since 1912 considerable additions have been made to the outfit of the ship; and this year we were provided with six stopcock water-bottles, an Ekman reversing water-bottle, three Ekman current-meters, a Lucas sounding-machine, and twelve reversing deep-sea thermometers of the latest type, especially valuable because by their use the probable error of the temperature readings was reduced from .15° to .03° F. Another refinement of apparatus was the attachment of the thermometer frames to the stopcock water-bottles, allowing the two sets of instruments to be used simultaneously in series, thus shortening the time for each set. We also carried a very complete set of horizontal and quantitative plankton nets, besides the usual trawls, fishing gear and harpoons; in short, we can at least congratulate ourselves on a thoroughly modern oceanographic outfit.

Our first section, across the Gulf of Maine and the western end of George's Bank, to the Continental Slope, occupied us from July 19 to July 21. Being then well within the sweep of the Gulf Stream, as shown by the temperature and plankton, we skirted the outer edge of the Bank to about longitude 66° 10′ W., whence we drew a second section across the Bank, to the deep basin of the Gulf. It would have been of interest to have extended the work to the abyssal depths further off shore; but our gear limited our observations to the upper 500 meters.

We next drew a section across the deep gully known as the "Eastern Channel," between George's and Brown's Banks, of great oceanographic interest because it is the only connection between the basin of the Gulf below the 100-fathom contour, and the deeps of the Atlantic; occupying stations successively in the gully, on Brown's Bank, in the channel north of the latter, and on the coastal bank off Cape Sable. On July 25 the *Grampus* anchored in Shelburne, Nova Scotia.

Two days later we made a current station a few miles off that port, anchoring the vessel in 30 fathoms of water, and taking measure-

ments of the surface current hourly for twelve hours (thus covering an entire tide, ebb and flood), and a few bottom current readings. The calm weather of that and the two preceding days gave an ideal opportunity for this work; hence the strong dominant set to the southwest which our instruments revealed is probably of considerable importance as an index of the long-shore flow of St. Lawrence water. From this point we ran a section across the coastal shelf, via Roseway Bank and the deep but circumscribed basin between it and La Have Bank, to the continental shelf, where we towed and took oceanographic observations to 500 meters.

Our program now called for a section crossing the shelf obliquely, to Halifax, and the first half of this line was successful. But an easterly storm drove us off our course, to shelter in La Have River, where we were held prisoners, first by northeast winds, then by fog, and finally by a violent southwest gale for four days. On reaching Halifax, August 2, we learned of the European war; and shortly received orders to return to United States waters.

On August 6 we sailed from Halifax, planning to make first a section across the Continental shelf normal to the coast as far as Emerald Bank; and then to run to the Gulf of Maine, making stations en route. The section was successful, and we were lucky enough to vary the monotony of the plankton hauls by the capture of a large swordfish, and of a sunfish (*Mola mola* Linn.). But thick fog set in on August 8 and drove us once more to Shelburne for shelter. Until the eleventh we lay at anchor, waiting for a change of weather; then lost patience and put to sea again. Our next field was the Gulf of Maine, where we located our stations at the same positions as those of 1912 and 1913, first in the northeast corner, then off Mt. Desert rock, and along shore to Gloucester, where we arrived on August 15. A week was spent in port; and on the 22d the *Grampus* sailed again, running east to the center of the gulf, and then to Cape Cod. Passing through Vineyard Sound we took our departure from No-Mans-Land on August 25 for a section across the Continental shelf, with stations at the 20-, 35- and 80-fathom contours, and one over the 1,000-fathom curve. We had supplied ourselves in Gloucester with bait and a long-trawl, and made two sets for tile fish (*Lopholotilus chamæleonticeps*) on the twenty-sixth. In 80 fathoms we caught only two; but in 105 fathoms an hour's set yielded 19, the aggregate weight being about 350 pounds. We occupied three stations during the run back to Gloucester, where we arrived August 28.

During the cruise complete oceanographic data were taken at 52 stations, ranging in depth from 15 to 250 fathoms; 126 tows were made with the horizontal nets: the quantitative net was used at 26 stations. The distance sailed was about 2,000 miles.

Statements as to the scientific results must await the completion of titrations of the water samples and the general examination of the plankton samples: the general report on the cruise, like that on the cruises of 1912[2] and of 1913 will be prepared in the Museum of Comparative Zoology.

HENRY B. BIGELOW

INTERNATIONAL OCEANOGRAPHIC EXPEDITION

At the present time arrangements are being completed to despatch the International Oceanographic Expedition under the command of J. Foster Stackhouse, F.R.G.S., for a seven years' voyage to chart the seas, and to determine as far as possible the exact position of the large number of rocks and reefs which have been reported during the last century.

Not since the days of the *Challenger* has so great an enterprise been undertaken, and it is highly desirable that no time be lost in making the fullest inquiries into these hidden dangers to navigation.

Over 3,500 dangers have been reported in the Pacific Ocean alone, and some of these no doubt account for the fact that during the last

[2] *Loc. cit.*

three years, the great insurance corporation of Lloyds has reported that over 134,000 tons of shipping in which they were interested, had mysteriously disappeared, involving a loss of over $13,000,000.

Whilst the first duty of the expedition will be to accurately chart the seas, the vessel will carry a staff of twelve scientific men, who will make a thorough investigation of all places visited, and in little known regions, parties will be left for short periods to carry on work in many branches of science. The expedition has been fortunate in enlisting the practical support of many governments, and after consultation with hydrographers in many parts of the world, the following itinerary has been agreed upon.

Leaving London in June, surveying work will be carried on in the North Atlantic, particularly in the vicinity of the sinking of the *Titanic*—where on three occasions a rock has been reported—thence down the Atlantic, after calling at several ports in this country, to the Panama Canal.

For the next four years investigations will be made in the Pacific Ocean, calling at most of the little known islands, and extending in its operations from the Sea of Ohkotsk to King Edward VII. Land.

On leaving the Pacific, the expedition will continue its work amongst the islands of the East Indies thence to Zanzibar by way of Columbo, Seychelles and Mombasa. Later considerable time will be spent in the unknown waters south of Madagascar. After calling at Natal, the vessel will once more sail for Antarctic waters, and endeavor to find the coast line between Queen Mary Land and the Weddell Sea. On leaving these latitudes a thorough investigation will be made of the Sandwich Islands, which are at present unsurveyed. Continuing westward oceanographic work will be carried on around South Georgia and the Falkland Islands. From Port Stanley a line of soundings will be made to Montevideo, examining several shallow patches in the South Atlantic, and thence by way of Trinidad, Martin Vaz and Cape Verde Islands to London.

A FOSSIL BOTANICAL GARDEN

The New York State Museum has received from Willard Lester, Esq., a deed of gift of about three acres of land in the town of Greenfield, two miles west of Saratoga Springs, which include the widely known "Cryptozoon Ledge," and this little property is set apart as a public geological park to be preserved and protected by the state because of its scientific interest.

The acquisition of this natural monument by free gift from a distinguished citizen of the state is not only the expression of a fine sentiment, but it brings under authoritative care a noteworthy natural phenomenon. The Cryptozoon is a marine calcareous alga which grew in great spherical bodies and in the Cambrian seas which deposited the limestones of this park, they were so abundant as to form extensive reefs. The Hoyt (Cambrian) limestone here forms a ledge which has been planed off by the ice sheet so that the Cryptozoa are smoothed down to a level surface and their interior structure beautifully displayed over an area of about a half acre. The gift, however, includes the extension of this ledge into other natural rock faces and abandoned workings of the old Hoyt quarry from which the geological formation takes its name.

The little property which is to be known as the "Lester Park" is of great natural beauty, both in itself and in its approaches, but not the least interesting thing about it is the fact that it is given to the state because of its geological and educational worth.

John M. Clarke

RECENT CHANGES IN THE ACTIVITIES OF THE BOSTON NATURAL HISTORY SOCIETY

On Wednesday evening, November 18, Professors H. L. Clark and Alexander McAdie addressed the first of the general meetings of the society which are being resumed this season. Dr. Clark spoke on New Australasian Echinoderms collected by S. S. *Endeavor* and Dr. McAdie spoke upon Exploring the Air. The interest shown by the large number of members present and the number of informal

discussions which took place afterward around the refreshment tables in the library augured well for the success of the new series of lectures.

It is the plan of the committee in charge to hold these gatherings on the first and third Wednesdays of each month until the middle of May. A large number of important communications have been promised by many officers of the various scientific establishments about Boston and Cambridge. Among these may be mentioned especially Professor M. L. Fernald who at the next meeting will speak upon the Flora of Block Island in Relation to that of Cape Cod. At the third meeting Professor Wallace W. Atwood will address the society on Mesa Verde, with remarks upon the ancient cliff dwellings in that region. Papers have also been promised by Professor W. M. Davis, on his recent researches on the Reefs of the South Pacific, by Professors J. B. Woodworth, P. E. Raymond, R. A. Daly, C. T. Brues, G. H. Parker, R. T. Jackson, H. W. Shimer, C. Palache, as well as by Dr. H. B. Bigelow and Mr. C. W. Johnson, the curator of the society's museum.

Many changes have been made in the Museum building since the lectures were discontinued five years ago. The lecture hall has been completely renovated and reequipped throughout, so that it is now an attractive and cheerful meeting place. Even greater changes may be seen in the other parts of the building. The museum has definitely decided to lay special emphasis on exhibits of New England natural history and with this end in view has entered into a scheme of cooperation with the University Museum in Cambridge. The long unused collections of foreign material are being sent there and the space devoted to exhibits of modern groups of New England mammals and birds. The other branches of New England natural history are also being appropriately displayed.

THE PROPOSED TORONTO MEETING OF THE AMERICAN ASSOCIATION

THE University of Toronto and the scientific men of the city had extended a cordial invitation to the American Association for the Advancement of Science and the Affiliated Societies to meet in Toronto a year hence. The circumstances which will make this impossible are explained in the following letters, addressed to Dr. L. O. Howard, permanent secretary of the association. Dr. Robert W. Falconer, president of the university, writes:

I have had a meeting of the committee which the university appointed to make arrangements for the reception of the American Association for the Advancement of Science, which accepted our invitation to meet here a year ago from next December. Our committee had been intending to use every effort to make the meeting a highly successful one, and we were hoping to create a widespread interest in the association. However, the outbreak of this terrible war has made an entirely new situation. At present the war hangs over us like a cloud so heavily that it would be very hard indeed for us to arouse interest in a scientific meeting. Also, the financial situation is anything but promising. We can not hazard any conjecture as to the length of the war, though we are making preparations on the assumption that it may last for another year at least. What condition we shall be in then no one can tell. Our committee thought that it was only right that I should thus place our conditions before you at this early stage on the chance that you might be able to change the place of meeting and come to us later, at a time when we shall be able to give you a welcome that we would be anxious to accord the association.

Professor J. C. Fields writes on behalf of the local committee:

At a meeting of the local executive committee we had an extended discussion on the prospects of the meeting of the American Association for the Advancement of Science to which we folks up here were all looking forward with so much interest. In view of the conditions already induced by the war and the uncertainty of the future it was the general disappointed sense of the members that we might not be in a position to arouse sufficient local interest or otherwise be able to assure such a success as we should wish for the meeting. Here everything is disorganized by the war and its issues overshadow everything else. Students and members of the faculty are drilling and many are likely to go to the front, so that we hardly know what will be the position of affairs here by this time next year. The members of the committee

thought that you might perhaps still be able to arrange for a meeting-place a year from December and that the association would do us the honor of meeting here some time later on when we have reverted to normal conditions.

SCIENTIFIC NOTES AND NEWS

At the Philadelphia meeting Section C will hold a session on the afternoon of Thursday, December 31, for the reading of papers, and a second session, jointly with Section K and the Society of American Bacteriologists, on Friday, January 1, at 10 A.M. The latter will be devoted to a symposium on "The Lower Organisms in Relation to Man's Welfare," for which the following program has been arranged:

"Theories of Fermentation," Vice-president C. L. Alsberg.

The general mechanism of the action of ferments: "Enzyme Action," C. S. Hudson.

A discussion of the chemical changes involved in the action of enzymes:

"Rôle of Microorganisms in the Intestinal Canal," A. I. Kendall.

"Use of Bacteria in the Treatment of Textile Fibers," F. P. Gorham.

"Microorganisms in their Application to Agriculture," C. E. Marshall.

Section K (Physiology and Experimental Medicine) will hold two meetings in Philadelphia during Convocation Week.

1. Thursday, December 31, 2 P.M. Laboratory of Hygiene, University of Pennsylvania.
   Vice-presidential address: Dr. Theodore Hough, "The Classification of Nervous Reactions."
   Symposium on Ventilation (jointly with the Society of American Bacteriologists):
   - (a) "Air-borne Diseases," Dr. A. C. Abbott, University of Pennsylvania.
   - (b) "Fundamental Physical Problems of Ventilation," Dr. E. B. Phelps, United States Hygienic Laboratory.
   - (c) "Standards of Ventilation—Hygienic and Æsthetic," Dr. C.-E. A. Winslow, New York State Commission of Ventilation.
   - (d) "Modern Developments in Air Conditions," Mr. D. D. Kimball, New York State Commission of Ventilation.
2. Friday, January 1, 11 A.M. Laboratory of Hygiene, University of Pennsylvania.
   Symposium on the Life of the Lower Organisms in Relation to Man's Welfare (jointly with Section C and the Society of American Bacteriologists).

The program will be announced later.

The program for Section M, Agriculture, is now complete. A single session will be held, on December 30, in the engineering building of the University of Pennsylvania, beginning at 2 P.M. The president of the association, Dr. Charles W. Eliot, will preside at the opening of the session, during the presentation of the address of the vice-president, Dr. L. H. Bailey, on "The Place of Research and of Publicity in the Forthcoming Country Life Development." A symposium will follow, on The Field of Rural Economics, participated in by the following speakers:

"Rural Economics from the Standpoint of the Farmer," Hon. Carl Vrooman, assistant secretary of agriculture.

"Credit and Agriculture," Professor G. N. Lauman, college of agriculture, Cornell University.

"Marketing and Distribution Problems," Mr. C. J. Brand, chief officer of markets, U. S. Dept. of Agriculture.

"The Distinction between Efficiency in Production and Efficiency in Bargaining," Dr. T. N. Carver, Harvard University.

A dinner was given in Boston on December 7 to celebrate the fiftieth anniversary of the connection of Professor Robert H. Richards with the Massachusetts Institute of Technology as student and teacher. The speakers were President Richard C. Maclaurin, in behalf of the institute; Mr. Eben S. Stevens of the same graduating class with Professor Richards, '68, of Quinebaug, Conn., in behalf of his fellows at the school; Professor Chas. R. Cross, '70, in behalf of the faculty and Jasper Whiting, '89, president of the Alumni Association in behalf of his association. The presentation was made to the institute of a portrait of Professor Richards by Miss Margaret F. Richardson, of Boston. It presents him, seated, considering a question which the open letter in his hand has brought to him.

At his elbow on the table are bulky volumes typifying his contributions to the literature of mining, while the upper right-hand field of the background shows a blackboard covered with figures and diagrams bearing on ore-dressing.

AT the Academy of Natural Sciences of Philadelphia on Tuesday evening, November 24, Dr. Henry Fairfield Osborn was presented with a Hayden medal. In presenting the medal Dr. Samuel G. Dixon called attention to the fact that Mrs. Emma W. Hayden, widow of the well-known scientific man, Ferdinand Venderveer Hayden, had established a deed of trust arranging for a sum of money and a bronze medal to be given annually to the author of the best publication, exploration, discovery or research in geology or paleontology, or a similar subject. Professor James Hall, of Albany, received the award in the first instance and the other nine succeeding him were Edward D. Cope, 1891; Edward Suess, 1892; Thomas H. Huxley, 1893; Gabriel August Daubree, 1894; Carl H. Von Littel, 1895; Giovanni Capellini, 1896; Alexander Petrovitz Karpinski, 1897; Otto Torell, 1898; Giles Joseph Gustav Dewalzue, 1899. In 1900 the deed of trust was modified so as to award a gold medal every three years. The first to receive the new medal was Sir Archibald Geikie; the second was Dr. Charles D. Walcott in 1908 and the third John Casper Branner in 1911.

PROFESSOR WILLIAM T. SEDGWICK, of the Massachusetts Institute of Technology, was elected president of the Massachusetts Public Health Association at its recent meeting at Jacksonville, Florida.

PROFESSOR GEORGE CHANDLER WHIPPLE, Professor W. T. Sedgwick, Dr. Milton J. Rosenau, Dr. William J. Gallivan, Dr. David L. Edsall and Dr. Joseph E. Lamoreaux, have been appointed the six members of the advisory council to Massachusetts' state commissioner of health, Dr. Allan J. McLaughlin.

DR. RICHARD P. STRONG, of the department of tropical medicine in the Harvard Medical School, has been appointed director of the laboratories of the hospitals and of research work of the United Fruit Co. The significance of the appointment is suggested in a letter from the Fruit Company to the University:

> Through a desire to cooperate with Harvard University in its investigation of tropical diseases we have properly equipped our hospitals with laboratories and have ample material constantly available in our wards, which we desire to place at your disposal for research in connection with the prescribed study of tropical diseases embodied in your tropical school.

THE Paris Academy of Medicine elected, on November 10, as national associate, Dr. Langlet, professor and director of the Ecole de médecine de Reims and mayor of that city.

THE grand cross of the Order of Alfonso XII. has been presented to the professor of pharmacy at the University of Madrid, Dr. J. R. Carracido, who is also a senator, and the Isabella cross to Dr. S. Recasens, professor of gynecology at the same institution.

A PRESS cablegram from Berne states that M. Hugo Claparède, professor of psychology in the University of Geneva, son of the Swiss minister to Berlin, has been dismissed from the university by the Swiss federal council on the ground that his expressed views concerning the violation of Belgian neutrality are inconsistent with the observance of neutrality of Switzerland. Professor Claparède had offered his resignation, following a demonstration against him by the students, but the federal council declined to accept it and instead dismissed him. The students' demonstration occurred on November 24 as Professor Claparède entered his classroom and read an address in which they asked him to resign, because "your attitude prohibits you to continue to occupy a public post remunerated by the state." Later the matter was brought up in the federal council through an interpellation by Deputy de Rabours.

MR. DAVID T. DAY has resigned from the United States Geological Survey to enter private practise. He has served the federal bureau since 1886, having been chief of the

division of mining and mineral resources until 1907.

Professor Eugen Oberhummer, of the University of Vienna, who has been appointed visiting Austrian professor to Columbia University, is expected to lecture during the second semester of the present year. Dr. Oberhummer visited the United States in 1910 and lectured in the geography departments at Harvard, Yale, Columbia, Johns Hopkins, Chicago, Wisconsin and other American universities.

Professor George R. Lyman, of the biology department, has resigned from the faculty of Dartmouth College, to accept a position as plant pathologist in the Department of Agriculture.

Mr. F. E. Watson has been appointed an assistant in the department of invertebrate zoology of the American Museum of Natural History. He will devote the greater portion of his time to Lepidoptera. Mr. Adolph Elwyn, who for the past nine years has been assistant in the department of anatomy and physiology, has resigned his position to become instructor in histology and biology at the Long Island College Hospital. Mr. Clarence R. Halter has been appointed to succeed Mr. Elwyn.

Professor William L. Bray, of Syracuse University, has been granted leave of absence for the current year and will spend the winter with his family in the Bronx, New York. During the summer and early fall, Professor Bray has been making a general survey of the vegetation of New York state with a view to the preparation of a bulletin to be published by the New York State College of Forestry. The results of the field exploration and collections will be worked up at the New York Botanical Garden during the winter.

Mr. William B. Peters, of the department of preparation of the American Museum of Natural History, and Mr. Prentice B. Hill, assistant in the department of geology, have returned from Weyer's Cave, Virginia, where they secured a quantity of material from grottoes which have lately been discovered in the cave. This is to be used, together with the collection made last year, in the reproduction of a typical grotto in the museum, work on which is progressing.

Dr. Arthur G. Webster, of Clark University, addressed the Chicago Chapter of the Sigma Xi at its regular autumn quarter meeting on December 5, upon the topic "The Rôle of Chance in Scientific Discovery."

The Mütter Lecture on Surgical Pathology for 1914 was given in the Thompson Hall of the College of Physicians of Philadelphia, on December 4, by Dr. Fred H. Albee, of New York City, on "The Fundamental Principles Involved in the Use of Bone Grafts in Surgery."

The will of the late Dr. Charles Sedgwick Minot, Stillman professor of comparative anatomy at the Harvard Medical School, contains a bequest of $1,000 for the improvement and increase of the embryological collection which he established at the Harvard Medical School, to which he left his scientific apparatus, books and pamphlets. Dr. Minot also bequeathed $2,000 to the Boston Museum of Natural History for its library.

Dr. Albert Charles Peale, geologist of the U. S. Geological Survey from 1871 to 1898, subsequently and till recently aid in the section of paleontology of the U. S. National Museum, died on December 6, aged sixty-five years.

Professor Angelo Celli, who held the chair of hygiene at the University of Rome and was at the same time chief of the National Board of Health and senator, has died at the age of fifty-seven years.

Dr. Alexander Campbell Fraser, professor emeritus of logic and metaphysics in Edinburgh University, a distinguished writer on philosophical subjects, has died at the age of ninety-five years.

Nils Christoffer Dunèr, formerly director of the observatory at Upsala, Sweden, died on November 10, in his eightieth year.

THERE have been killed in the war, Peodwaair Frick, director of the Royal School of Forestry at Münden, and Dr. Heinz Michaelson, assistant in the Institute for Oceanography in Berlin.

THE directors of the Fenger Memorial Fund announce that the sum of $600 has been set aside for medical investigation in 1915. The money will be used to pay all or part of the salary of a worker, the work to be done under direction in an established institution, which will furnish the necessary facilities and supplies free of cost. It is desirable that the work undertaken should have a direct clinical bearing. Applications giving full particulars should be sent to L. Hektoen, 629 S. Wood St., Chicago, before January 15, 1915.

IN the will of the late Miss Dessie Greer, an annual member of the American Museum of Natural History, the museum is designated as the ultimate beneficiary of a fund of $90,000.

BY the will of the late William Endicott, of Boston, a bequest of $25,000 for cancer research is made to Harvard University.

THE American Museum of Natural History has received from Messrs. M. Guggenheim and Sons the gift of a small collection of prehistoric objects found in a copper mine at Chuquicamata, Chile. The collection consists for the most part of hafted stone hammers and wooden scrapers. These were the implements used by the Indians in pre-Spanish days in collecting the copper (atacamite) with which they made knives and other implements.

IN the New York City building at the Panama-Pacific Exposition, the gardens, libraries and museums of New York will have a booth some twenty-four feet long at the left of the entrance, with interior and exterior wall space for the display of photographs. Each institution of the city has been allotted approximately ninety square feet of surface.

AT a meeting of members of the Lister Institute, London, under the presidency of Sir Henry Roscoe, held on November 18, a proposal to authorize the governing body to effect an amalgamation with the Committee for Medical Research, established under the National Health Insurance Act, 1911, with clauses provisionally agreed to by the treasury was rejected.

AT the recent meeting of the National Association of State Universities, in Washington, there were five municipal universities, institutions directly controlled and supported by cities, represented. President Charles William Dabney made the opening address on "The Municipal University." At the close of the meeting President Wheeler, of the University of California, addressed representatives of urban universities on the importance of their service to American institutions. An association to be called the Association of Urban Universities was then founded and all institutions cooperating with cities and training for public service were invited to become members. The purposes of the association were announced to be the study of the problem of the city in its broadest sense, and the training of men and women to serve the state. Dr. Dabney, of the University of Cincinnati, was elected president; Dean Everett W. Lord, of Boston University, vice-president, and Dr. Walter E. Clark, of the College of the City of New York, secretary.

THE twenty-seventh annual meeting of the American Economic Association will be held at Princeton, N. J., from December 28 to 31. The American Statistical Association and the American Sociological Society will hold their annual meetings at the same time and place. Several joint sessions will be held. The first session is to be a joint meeting addressed by the presidents of the three associations—Messrs. John H. Gray, John Koren and Edward A. Ross. The morning session on December 29 is to be on "Speculation on Stock Exchanges and Public Regulation of the Exchanges." Papers will be presented by Messrs. Samuel Untermyer and Henry C. Emery. The afternoon session on December 29 will be on "Market Distribution." The morning session on December 30 will be a joint meeting with the American Statistical Association to discuss "The Statistical Work of the United States Government"; the after-

noon session will be devoted to "The Relation of Education to Industrial Efficiency" and "The Effect of Inheritance and Income Taxes on the Distribution of Wealth." The concluding session on December 31 will be a joint meeting with the American Sociological Society on "The Public Regulation of Wages."

At a meeting of Yale University men interested in engineering at the Yale Club, on December 4, a constitution was adopted forming a Yale Engineering Association. Discussion of this project has been under way for a year, and a committee, consisting of E. G. Williams, '87S.; Calvert Townley, '86S.; Bradley Stoughton, '93S.; W. C. Tucker, '88S., and Professor L. P. Breckenridge, '81S., of the Scientific School, has been at work drawing up the organization papers. The main purpose of the association will be "to advance the interests of engineering education at Yale and to promote the better acquaintance and fellowship of Yale engineers."

The *Bulletin* of the American Geographical Society states that for two years past the Department of Historical Research at the Carnegie Institution has given a considerable amount of time to planning an atlas of the historical geography of the United States and collecting materials for its construction. Several specialists, including Professor Frank H. Hodder, of the University of Kansas; Professor O. G. Libby, of the University of North Dakota; Professor Max Farrand, of Yale University, and Professor Jesse S. Reeves, of the University of Michigan, each proficient in one or more subjects to be covered by the atlas, have been called to Washington to conduct investigations for the proposed work. The department of historical research wishes to make the atlas of the greatest possible use to the teachers and writers of American history and is seeking all the helpful cooperation that can be secured. According to present plans the completed atlas, exclusive of text, will contain 200 pages measuring about 22 by 14 inches. The largest maps will be approximately full-page maps, many others will be about one fourth that size and many still smaller. The area covered will be generally the whole or a part of continental United States. It may occasionally be found desirable, however, to represent our detached possessions, adjacent parts of Canada and Mexico, the West Indies and parts of the north Atlantic and north Pacific oceans. Excepting maps illustrating the geology of the country and its early aborigines, all the maps will fall within the period from the discovery of America in 1492 to the present time. The general headings are expected to include physical geography, aborigines, early maps of America, routes of explorers and colonizers, boundaries and divisions, industrial and social maps, and political, city and military maps. A considerable portion of the atlas will be devoted to political statistics, which will be treated somewhat after the method of Professor Turner and his students. It is to be hoped that the specialists in charge will have all the collaboration that can add to the value of the proposed atlas.

A conference of Pacific coast horticulturists was called by Governor West, of Oregon, to meet at the Agricultural College early in December to secure better and uniform fruit inspection throughout the western fruit-growing states. After hearing reports and recommendations from the horticultural commissioners of Oregon, California and Washington, a joint committee of producers and distributors was appointed to prepare a bill embodying the features endorsed by the conference, to be presented to the state legislatures with the recommendation that it be enacted into law. The joint committee called in as advisory members Professor H. F. Wilson and Professor H. S. Jackson, entomologist and plant pathologist, respectively, of the Oregon Station. The measure as framed by the committee provides effective inspection both within the states and from other states, with as little restriction as is consistent with efficiency. The ultimate aim of the conference is to secure uniform horticultural laws throughout the entire country.

UNIVERSITY AND EDUCATIONAL NEWS

Two gifts of $100,000 each for the development of a graduate course in preparation for

business and business administration at the Sheffield Scientific School of Yale University, are announced. The donors are Frederick W. Vanderbilt, of the class of 1876, S., and a graduate of the class of 1887, S., whose name is not made public. The new course will be for one year, and, if possible, two years. It is expected that it will be open to students at the beginning of the next academic year.

A GIFT of $10,000 to Smith College has been made by Mr. and Mrs. A. J. White, of Brooklyn. Half of the money is to be applied toward payment for recent improvements on the Lyman Plant House. The remainder will constitute a permanent endowment fund for repairs to the house, purchase of new materials, and encouragement of botanical study.

A BEQUEST of $10,000 to St. Lawrence University at Canton, N. Y., is made under the will of Mrs. Kate A. L. Chapin, of Meriden, Conn.

AT its last session, the council of the Université de Paris unanimously resolved that Belgian students who before the war had been matriculated in one of the universities of their own country might become matriculated in the schools of the Université de Paris without having to pay the matriculation, inscription and library fees. Young Belgians from the Belgian establishments of secondary education will likewise be received if they fulfill the conditions exacted by the Belgian universities. In default of diplomas and certificates, the young people may prove their qualifications by such means as are possible, for instance, certificates of French or Belgian diplomatic or consular agents.

PROFESSOR and Mrs. Frederic S. Lee have given to Columbia University the sum of $20,000 to establish a fund for the use of the department of physiology. It is intended that for the present the income shall be used for the maintenance of the library of the department. The university is about to acquire the valuable collection of books belonging to the late Professor John G. Curtis and consisting of ancient and medieval works on the history of physiology.

DR. ROBERT BENNETT BEAN, of the department of anatomy in Tulane University, has been advanced from the rank of associate professor of anatomy to that of professor of gross anatomy in the department of anatomy, and Dr. Sidney S. Schochet and Mr. Charles W. Barrier have been appointed instructors in anatomy.

DISCUSSION AND CORRESPONDENCE

TEACHING AND RESEARCH

THE suggestive article by Professor Cattell in SCIENCE of October 30, p. 628, leads me to offer a few observations growing out of my own experience. One who is wholly a teacher tends to organize his work on a more or less permanent basis, with definite limitations. If he possesses good natural ability, he becomes very efficient, teaching clearly and logically what appear to him to be the more important things. He tends more and more to fixed opinions, and to arbitrary divisions between the things which should be known and those which need not be known. Such a man will be tremendously indignant because X does not know a, but feel no shame on account of his own ignorance of the analogous facts b, c, etc.

One who is primarily interested in research finds his mind much occupied with various trains of thought, and his interest tends to center about *uncertainties* rather than *certainties*. Even as he teaches, things assume new aspects to his mind. Much has been made of the saying that Kelvin made discoveries while lecturing, but (in a small way) this is probably a common experience.

The teacher who does no research tends to become increasingly confident of his own knowledge, and conveys this feeling to his class. One who is primarily an investigator, unless he works in a very small field which he has thoroughly in hand, is continually reminded of his own limitations and of the vastness of the unknown. He is humbled by the mistakes he can not help making, and feels and appears more ignorant.

I have tried to define extreme cases; most of us are blends or mosaics of the two types. It must be admitted, I think, that when a teacher is keenly interested in research, his teaching suffers in some respects. It gains in others, and the question is, how to find the optimum condition of affairs. We seem to be attacking the old problem of progress. We are reproducing on a minute scale the phenomena of evolution. The absence of progress and excessive progress are alike detrimental, and there is a shifting optimum between. My personal opinion, which tends to grow stronger with time, is that our universities mostly err on the side of conservatism and dogmatism, so that additional emphasis on progressive policies becomes desirable. By a sort of paradox, conservative teachers with rigid ideas are frequently undecided or indifferent as to the merits of the systems they expound, rather priding themselves on their academic impartiality. On the other hand, progressive thinkers will be filled with particular ideas at particular times, and will then appear very confident; thus, superficially, our definitions may seem reversed. In reality, the indecision of the conservative is due to the limitations of his field, and is quite different, psychologically, from the indecision of a man who is ardently seeking a solution which still evades him.

There is, of course, another matter to be considered. Granting that a research man, with his necessary limitations, makes a better teacher than one who is only a teacher, what if he loses interest in his teaching? Many will remember instances of this sort, and it is customary to put the whole blame on the man who has thus failed. Is it not possible that the loss of interest is sometimes accelerated by the indifference of those who do not wish to receive the only sort of thing the man can give? There is so much to do in this world that among the numerous possible activities presenting themselves there is a sort of survival of the fittest. No one is justified in "wasting his sweetness on the desert air," if he can help it. The problem then becomes one of creating an atmosphere in which good teaching can flourish, as well as securing good teachers.

On the whole, it appears that we can not have every good thing at once. It is for each department and man to seek an optimum which will certainly differ according to times and circumstances. It may, however, be worth while to try to understand the psychology of each situation as it arises.

T. D. A. Cockerell

University of Colorado,
November 16, 1914

A NOTE ON APPARATUS REPAIR

To the Editor of Science: Doubtless there are many who like the writer have met with accidents where a fused-in-platinum electrode has broken off at the very surface of the glass. Such a thing occurred while setting up Hoffman's apparatus for electrolysis.

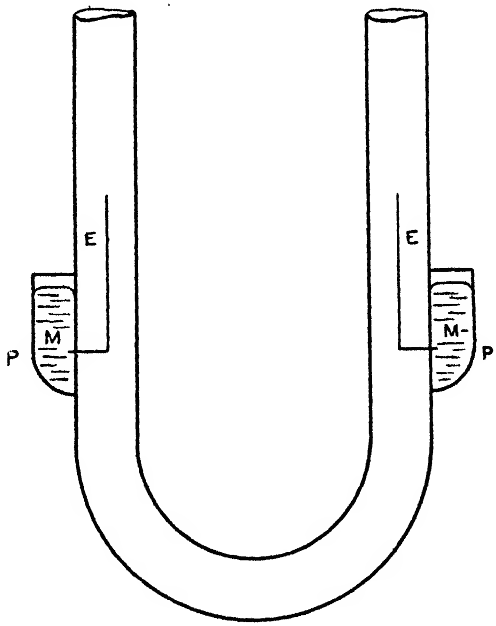

Fig. 1.

In order to repair it the writer took a piece of chamois skin cut to an appropriate size and shape, formed it into a little sack and fixed it with sealing wax to the outer wall of the vertical tube. This sack was so placed that when

nearly filled with mercury the broken end of the platinum wire was immersed in the liquid. To make a connection with the battery circuit it was simply necessary to insert a connecting wire into the sack containing the mercury. This makeshift has worked splendidly many times and there seems no reason why it should not work indefinitely. The sketch shows the arrangement above noted. *E,E,* are electrodes, *M,M,* mercury, *P,P,* the pockets.

The thought occurs to the writer that it would be possible to place on certain pieces of glass apparatus designed with fused-in-platinum wires some sort of glass pocket, the function of which would be the same as the leather pocket above mentioned. It is obvious that this arrangement would do away entirely with the risk of accident.

In the case of much glass apparatus where the electrodes are inserted through the glass the outer terminals are metal rings somewhat securely fixed in place—for example as in vacuum tubes. Even in electrolytic apparatus such a scheme may be used at times. Yet, while that arrangement is certainly an improvement over the projecting-out piece of platinum wire, it seems that the above scheme would lend itself to even more careless and safe handling.

It is further suggested that the same idea might be used on certain forms of vacuum tubes.

G. B. O.

Colby College

THE TENTERTON STEEPLE AND THE GOODWIN SANDS

On reading the reference to the Tenterton (Tenterden) Steeple and the Goodwin Sands in the article on "Heredity and Environment" by Mr. Henry Leffman,[1] I wondered whether the reference in question would be generally understood. I did not think so, and in order to test the matter I stated the reference and its connection in a meeting of some seventy high-school teachers, among whom were many A.B.'s, several A.M.'s and a sprinkling of Ph.D.'s. I asked those who understood the reference to raise a hand. The result was even more meager than I had anticipated—not a single hand went up.

Although most readers of the article referred to may have reached the conclusion which the author evidently took for granted they should reach, yet because the Goodwin Sands have recently been referred to in the war news from Dover (England)—the Sands are in that vicinity—and further because there may be some readers of Science who are still in the dark about the relation between the "Sands" and the "Steeple," therefore I thought that a brief account of the origin of the incident might not be altogether unprofitable.

In a "Compendium of English Literature" by Charles D. Cleveland, published at Philadelphia by J. A. Bancroft & Co., in 1869, may be found selections from the more prominent authors from Sir John Mandeville to William Cowper. On page 65 of this compendium a biographical sketch of Hugh Latimer is found, and following that are a few selections from his writings. One of the selections (p. 67) is entitled "Cause and Effect," and reads in part, as follows:

> Here is now an argument against the preachers. Here was preaching against covetousness all the last year, and the next summer followed rebellion. *Ergo*, preaching against covetousness was the cause of the rebellion—a goodly argument. Here now I remember an argument of master More's which he bringeth in a book that he made against Bilney; and here by the way I will tell you a merry toy.
>
> Master More was once sent in commission into Kent, to help to try out (if it might be) what was the cause of the Goodwin Sands, and the shelf that stopped up Sandwich haven. Thither cometh Master More, and calleth the country afore him, such as were thought to be men of experience, and men that could of likelihood best certify him of that matter concerning the stopping of Sandwich haven. Among others came in before him an old man, with a white head, and one that was thought to be little less than a hundred years old. . . . So master More . . . said: "Father (said he), tell me, if you can, what is the cause of this great arising of the sands and shelves about this haven, . . . [so] that no ships can arrive here? . . . ye of likelihood can say most to it, or at leastwise,

[1] Science, October 23, 1914, pp. 593–594.

more than any man here." . . . "Yea, forsooth, good master (quoth this old man), for I am well nigh a hundred years old. . . . [and] forsooth, sir, (quoth he), I am an old man; I think that the Tenterton-steeple is the Cause of the Goodwin Sands. For I am an old man, sir, (quoth he), and I may remember the building of the Tenterton-steeple, and I may remember when there was no steeple at all there. And before that Tenterton-steeple was in building, there was no manner of speaking of any flats or sands that stopped the haven, and therefore I think that the Tenterton-steeple is the cause of the destroying and decay of Sandwich haven." And so to my purpose, is preaching God's word the cause of rebellion, as the Tenterton-steeple was cause that Sandwich haven was decayed.

MAXIMILIAN BRAAM

HUGHES HIGH SCHOOL,
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SCIENTIFIC BOOKS

Roger Bacon. Essays contributed by various writers on the occasion of the commemoration of the seventh centenary of his birth. Collected and edited by A. G. LITTLE. Oxford University Press, Oxford. 1914. Pp. viii + 426.

American universities and American scholars are fortunate in the undisputed right to celebrate the anniversaries of any of the great teachers that the world has known. Oxford has the first claim to commemorate the name and fame of Roger Bacon, for there the "learned doctor" spent many years, both as teacher and student. The committee on the commemoration of the seventh centenary of Roger Bacon's birth has erected a statue of Roger Bacon, by Mr. Hope Pinker, in the University Museum at Oxford, has issued the volume of memorial essays under discussion, and has raised funds for the publication of certain unpublished works of the great Franciscan. In America Columbia University has celebrated this anniversary with appropriate exercises, including a pageant; at the University of Michigan the Research Club devoted its annual memorial meeting to public exercises on Roger Bacon, with papers by Professors Dow, Lloyd, Guthe and Tatlock, discussing the life and times, the philosophy, the scientific activity and the relation to magic and astrology of Roger Bacon. The *Open Court Magazine* dedicated the issue of August, 1914, entirely to Bacon, and foreign journals, such as the *Revue des deux Monds*, have taken this time to discuss the contributions to various fields made by Bacon.

Simply the titles of the essays in the present volume, and the list of contributors, pay such a high tribute to the intellectual activity of Roger Bacon that it seems desirable to present the list of contents:

I. Introduction: On Roger Bacon's Life and Works. By A. G. Little, M.A., Lecturer in Paleography in the University of Manchester.

II. Der Einfluss des Robert Grosseteste auf die wissenschaftliche Richtung des Roger Bacon. Von Universitätsprofessor Dr. Ludwig Baur in Tübingen.

III. La Place de Roger Bacon parmi les Philosophes du xiii^e siècle. Par François Picavet, Secrétaire du Collège de France, Directeur à l'École pratique des Hautes-Études.

IV. Roger Bacon and the Latin Vulgate. By His Eminence Francis Aidan Cardinal Gasquet, D.D., O.S.B., President of the International Commission for the Revision of the Vulgate.

V. Roger Bacon and Philology. By S. A. Hirsch, Ph.D.

VI. The Place of Roger Bacon in the History of Mathematics. By David Eugene Smith, Professor of Mathematics, Teachers College, Columbia University.

VII. Roger Bacon und seine Verdienste um die Optik. Von Geheimer Hofrat Professor Dr. Eilhard Wiedemann in Erlangen.

VIII. Roger Bacons Lehre von der sinnlichen Spezies und vom Sehvorgange. Von Dr. Sebastian Vogl in Passau.

IX. Roger Bacons Art des wissenschaftlichen Arbeitens, dargestellt nach seiner Schrift "De Speculis." Von Dr. J. Würschmidt in Erlangen.

X. Roger Bacon et l'Horreur du Vide. Par Pierre Duhem, Membre de l'Institut de France, Professeur à l'Université de Bordeaux.

XI. Roger Bacon: His Relations to Alchemy and Chemistry. By M. M. Pattison Muir, M.A., Fellow, and formerly Prælector in Chemistry, of Gonville and Caius College, Cambridge.

XII. Roger Bacon and Gunpowder. By Lieutenant-Colonel H. W. L. Hime, (late) Royal Artillery.

XIII. Roger Bacon and Medicine. By E. Withington, M.A., M.B.

XIV. Roger Bacon in English Literature. By Sir John Edwin Sandys, Litt.D., LL.D., F.B.A., F.R.S.L., Public Orator in the University of Cambridge.

Appendix. Roger Bacon's Works, with references to the MSS. and Printed Editions. By A. G. Little.

A critical discussion of these fourteen essays is obviously beyond the power of any one individual. However, any scholar in any field will find much that is of interest and even of profit, in intellectual stimulus, in all of these essays. Roger Bacon came at a time when the world of the Middle Ages was reawakening. The learning of the Greeks and the Byzantines, the learning of the Jews, and the learning of the Arabs, were made accessible to the scholars of that time by the numerous translators of the eleventh, twelfth and thirteenth centuries; although Roger Bacon had much to say about the inaccuracy of many of the translations with which his readers were familiar, the fact remains that to the authors of these works is due in large measure the revival of learning which was in full swing in the thirteenth century. It need then occasion no surprise that much of the material which is found in the writings of Roger Bacon may be found in the writings of Greek, Jewish and particularly Arabic scholars who preceded him. So, too, as Baur points out, the teachings of Bacon may frequently be traced to the influence of Robert Grosseteste, the great Bishop of Lincoln and a scholar entirely of the type of Bacon. Nor does this dependence upon earlier writers diminish the importance and significance of Bacon's work. There are now and then those geniuses who proceed far in advance of the main body of scholars; but their work in a large measure is lost unless, in some way, the great mass of scholars can arrive at the point to which the advance guard has attained. Only in this way can we understand how it happened that the work of Archimedes, so much in advance of its age, exerted so little influence for fifteen hundred years. Archimedes lacked continuators and those who could popularize his work.

The modern point of view in many discussions is most striking. Bacon would have the ancient languages studied for a more complete and precise understanding of the Scriptures; he urged the study of modern languages in order to promote trade, to facilitate political relationships, and for the conservation of peace. The accounts of the great travellers of his time, and the geography of the world, were of intense interest to him. His interest in mechanical discoveries, and a somewhat prophetic vision, are evident in his statement: "I have not seen a flying machine, and I do not know any one who has seen one; but I know a wise man who has thought out the principle of the thing."

This work can be commended in its entirety to all students of science. The volume is interesting and instructive in many ways. Any one who reads the work through will have obtained a very clear idea of the intellectual activity, and the life of the students in the Middle Ages, as well as a renewed appreciation of the underlying unity of all learning.

The first three essays in the work are written in English, German and French, respectively; the following three are written by a Cardinal of the Roman Church, a Jew and an American. May this kind of international cooperation speedily return, and wipe out the memory of these terrible days when gunpowder, possibly invented by Roger Bacon and used by him as an amusement for children, is being used by civilized man for the destruction of his fellows.

LOUIS C. KARPINSKI
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The Birds of the Latin Poets. By Ernest Whitney Martin. Leland Stanford Junior University Publications. University Series. Stanford University, California. Published by the University. 1914. Pp. 260.

This, the latest contribution to the literary side of ornithology, covers a virgin field. In "The Birds of the Latin Poets" Professor Martin has attempted to bring together from the Roman poetical writers their passages which mention birds of any particular kind; and an examination of his text and appended bibliography shows how admirably he has succeeded. Very wisely no attempt has been made to include either prose passages or references to birds in general.

After a brief preface these quotations form the major portion of the book, in which the arrangement is conveniently alphabetical by names of birds, from *Acalanthis* to *Vultur.* Under the Latin name or names of each bird is given a Greek equivalent or equivalents, the English names, and the scientific name or names, the last in many cases not more than generic. Comment on the use of two or more Latin names for the same bird is sometimes added, together with various notes and explanations, including many mythological references. There are mentioned also the conspicuous avian parallels of American poetical literature, these birds being not the scientific equivalents, but, as our author very well puts it, "the birds which have aroused similar reactions in the feelings of their poetic observers." A list of American poems thus pertinent to the bird in hand is given when possible; also a list of Latin epithets, some of the latter being especially interesting, as, for instance, in the case of *Aquila.* Then follow the various Latin quotations arranged under different topics, and liberally interspersed with the author's comments and with extracts in English, mostly from American poets. These passages for each bird occupy from half a page, or even less, to as many as 17 pages. Not counting synonyms entered for convenience of reference, 70 different birds are thus treated, among which, as of particular interest, may be mentioned *Anser, Aquila, Cycnus, Hirundo* and *Luscinia.*

Following this treatment of individual birds are four "Notes" of several pages each—virtual appendices—on "The Spring Migration and Spring Song"; "The Fall Migration and the Fall Song"; "The Hibernating of Birds"; and "Ruscinia." Under the first of these headings quotations are given to show the attitude of both American and Latin poets toward the spring movements of birds; and under the second caption similar treatment is accorded the fall migration. The mythical hibernation of birds is considered in like manner in "Note III." The last of these "notes" is devoted to a discussion of the origin and identification of the "ruscinia," and of the application of this name to the nightingale. The author's conclusions regarding this obscure question come probably as near the true solution as is now possible.

A "Bibliography of the Principal Literature Consulted" and an index of all the citations from Latin authors complete the book.

This treatise has been written, and its numberless quotations collected, for the purpose of showing the Roman attitude toward bird life so far as it is depicted by the Latin poets. The result is thus much more than a mere collection of quotations, and really gives an insight such as perhaps we could obtain in no other way. With our present-day knowledge of birds it is somewhat difficult for us to realize how meager and vague, when the Latin poets lived and wrote, was even the scientific information regarding bird life, and how interwoven and bound up with tradition, mythology and augury were even the common facts of every-day observation; a condition which renders difficult, indeed, often impossible, the very identification of the birds that they had in mind and at the tip of the pen. By reason of this we ought the more to appreciate the additional light that comes from researches such as these of Professor Martin's. Of notable interest is the Roman attitude toward the song of birds, as disclosed by the poets. This is, as our author expresses it: "that they nearly always felt a tone of sadness in the songs of their favorite song birds, where we are inclined

to feel joy and ecstacy." This, our author, with much reason, holds, is due to the ancient prevalent belief in metamorphosis, through which the Roman thought of his birds not simply as birds, but also as human beings in changed form. Another observation worthy of mention, to which our author is led by his study of the writings of American poets, is that in the latter is found much more traditional Greek and Latin bird lore than the ordinary reader realizes.

It is unfortunate, though perhaps unavoidable, that of a number of the birds treated, identifications more specific were not made. Moreover, while we do not forget that the purpose of the book is primarily not scientific, but literary, we are of the opinion that its literary flavor would not have suffered from the use of proper modern scientific names instead of the antiquated terms that appear under many of the species. Any well-informed ornithologist could have furnished these. Less excusable is the statement (page 242) that the nightingale is not a thrush, but a member of the "silvidæ." A good index of bird names would have aided much in finding references scattered through the text.

Few of us, however, can fully appreciate the great amount of research involved in the task that the author has set for himself; and we owe him a debt of gratitude for having put before us in such readable form the results of his industry; and for having produced a treatise that will be interesting and profitable alike to classicist, litterateur, and ornithologist. It furthermore impresses us anew with the thought that in all phases of ornithological study there are the same endless possibilities that these lines of the poet suggest:

Quis volucrum species numeret, quis nomina discat?
Mille avium cantus, vocum discrimina mille.

HARRY C. OBERHOLSER

A Montane Rain Forest. A Contribution to the Physiological Plant Geography of Jamaica. By FORREST SHREVE. Carnegie Institution of Washington, Publication No. 199.

This admirable presentation of the results of eleven months' study of the forests of the Jamaican mountains should demonstrate the value to American botany of a laboratory in the primeval forest of the western tropics. It ought also to prove the pioneer of a whole series of exact distributional and experimental studies of American tropical vegetation.

The main ridge of the Blue Mountains, which varies from 5,000 to 7,428 feet in height, lies directly across the path of the northeast trade winds. In consequence of this the climate of the northern, or windward side is fog-drenched and constantly humid, with a rainfall of 160 inches. Two miles south of the ridge, however, the precipitation is but 105 inches, the percentage of sunshine is far higher and hence the climate is decidedly warmer and less humid. The whole region is frostless. The annual range of temperature is about 42° Fahrenheit, and the daily range close to 12°.

The flora of the rain forest is less varied than that of the neighboring tropical lowlands. The composition of the flora is rather less like that of these lowlands than that of a temperate forest. A list is given of the higher plants, which is not intended to be complete, but does embrace the more characteristic species. It includes 93 pteridophytes and 187 seed-plants.

The vegetation of the untouched rain-forest is dominated by a nearly continuous covering of trees, very few of which get to be more than 50 feet high and 2½ feet in diameter before being undermined by the rapid erosion characteristic of the region. On the ridges and higher slopes the trees are reduced to 15 or 20 feet in height. The floor of the forest, especially of the windward slopes and ravines, supports many shrubs and has an abundant carpet of herbaceous mosses, ferns and seed-plants, while numerous epiphytic mosses, ferns, orchids and bromeliads stick to the branches of the trees and lianes often overspread their tops. On the leeward slopes, and on the ridges of both sides trees are more scattered, the herbaceous ground vegetation is sparse, but thickets of shrubs or of climbing ferns and

grasses cover the soil between the trees. This difference in the types of plant covering on the windward and leeward sides is the most striking feature of the distribution of the vegetation of these mountains. A comparison of the vegetation of a valley bottom with that of its own higher bounding slopes, even on the beclouded windward side, shows a difference of the same sort as that just mentioned, though somewhat less marked.

Detailed instrumental measurements of the physical characteristics of several selected habitats were made by Shreve, between October, 1905, and June, 1906. These studies of the climate, in the valleys and on the ridges and at the top of the forest canopy as well as on its floor, together with his inquiry into the transpiration capacity of typical rain-forest plants, are perhaps the most unique features of his contribution. The habitat in which the climatic peculiarities of the rain-forest are most accentuated, as was demonstrated by the aid of the air and soil thermographs, the hygrometer and atmometer, is the floor of the windward ravines. Here soil moisture is abundant, the leaves are dripping wet with rain or fog for weeks together. The humidity is constantly high; the rate of transpiration is very low and the light filtering through the screen of foliage and of cloud is faint even at midday. On the slopes, and especially on the ridges, of both windward and leeward sides of the mountains, where air currents and sunlight have freer access, the soil is still moist, but the leaves are less often covered with water drops, and measurement shows that the humidity of the air is less, the rate of transpiration is higher and there is a somewhat greater daily range of temperature. These climatic differences, taken together with the characteristic differences in the vegetation of the two sides of the range, make it clear that the general distribution of the vegetation here is controlled primarily by the moisture content of the air rather than by that of the soil. The latter is probably adequate in all but a few restricted locations.

One very interesting feature of the seasonal activity of the rain-forest trees is that while certain of them vegetate actively throughout the year, others growing right beside them show a well-marked winter rest. Most of the former species are allied with the lowland tropical forms, while the latter are allied rather with north temperate genera.

Most plants of this montane region grow quite slowly, probably in consequence of the moderate temperatures, a low transpiration rate and the often weak light. The uncoiling leaves of certain ferns show the most rapid growth observed.

The rate of transpiration was studied in 8 or 10 species. One rather unlooked for result was that the rate of transpiration for these plants, *under the conditions prevailing in the rain-forest*, is not *very* unlike that found for many Arizona plants *when growing under desert conditions*. As a matter of fact the desert plant, in spite of its highly protected surface, loses more water per square centimeter of surface, in its native habitat, than the plant of the rain-forest when growing in its home.

One other interesting conclusion of the author from this comparison of rain-forest plants and desert plants is that the continuous extreme humidity, the low temperature and weak illumination give conditions approximately as unfavorable to plant growth as are the opposite extreme conditions of arid regions. The tropical lowlands and the moist temperate regions are regarded as the homes of the most luxuriant and most varied floras of the earth, and the places of origin of new structures and new species.

Duncan S. Johnson

Engineering Geology. By Heinrich Ries and Thomas L. Watson. New York, John Wiley & Sons. Octavo, bound in cloth. 672 pages.

This volume fills a special field in which it has no rival. It is arranged particularly for the use of the student of civil engineering, but the full treatment of many subjects and the extensive lists of standard papers will make it also a valuable reference work for engineering libraries. In many engineering

schools the curricula of the students of civil engineering provide one term only for geology. The student is expected to master the principles of geology and to find the applications in that brief time without any previous training in physiography, mineralogy, petrology or paleontology. It is obviously a difficult task to arrange the material so that the groundwork of principles is made clear in the short time allotted for the study, and applications emphasized sufficiently to make the study of much practical value. This difficulty is happily met in this volume by brief and concise statements of principles followed by ample and well-chosen illustrations.

The book is well arranged for the mature and serious-minded beginner who wishes to get the maximum of material in a short time. The more advanced student will find also many applications of geology brought from widely scattered sources and some which are not treated elsewhere. Separate chapters are devoted to rock minerals, rocks, structural geology and metamorphism, rock weathering and soils, rivers, lakes, wave action, underground waters, landslides, glacial deposits, cements, clays, coal, petroleum and gas, road material, and ore deposits. The mechanical features of the work are excellent; particularly noteworthy are the clearly executed photographs and line drawings.

W. H. EMMONS

MINNEAPOLIS

Die Umwelt des Lebens. Eine physikalisch-chemische Untersuchung über die Eignung des Anorganischen für die Bedürfnisse des Organischen. Von LAWRENCE J. HENDERSON; übersetzt von R. BERNSTEIN. Wiesbaden, J. F. Bergmann. 1914.

This volume is the German translation of the author's book, "The Fitness of the Environment," recently reviewed in these columns.[1] There are a few additional features; the table of contents contains a very complete and convenient summary of the whole book, important sentences or paragraphs are italicized, and a brief final chapter has been added; there is also an interesting and apposite quotation from du Bois-Reymond in a footnote on page 161; and the subject-index has been omitted. Otherwise the book remains unchanged.

[1] SCIENCE, N. S., 1913, p. 337.

In his final chapter the author calls attention to the existence of "a hitherto unrecognized order among the properties of the chemical elements,"—referring to the remarkable manner in which certain fundamental properties, which have largely conditioned the course taken by the evolutionary process, are distributed among the elements. These properties, far from being distributed with approximate uniformity—as the periodic system might lead us to expect—attain strongly marked maxima, or are, so to speak, concentrated, in relatively few elements, which at the same time are among the most abundant and widespread, namely: carbon, hydrogen and oxygen. "As a result of this fact there arise certain characteristics of the cosmic process which could not otherwise occur:" the implication is that at the outset of cosmic evolution there were present in advance all of the conditions needed for the development of physico-chemical systems having *vital* peculiarities, *i. e.*, possessing the complexity, activity and stability in a changing environment which are essential to living organisms. The properties of these three elements—and of no others—show a most detailed "fitness" for the production of just such systems. If, therefore, the main outcome of evolution be regarded as the development of living organisms, "the biologist may rightly regard the universe in its very essence as biocentric."

The volume is attractively printed and is dedicated to Karl Spiro.

R. S. L.

THE OXIDATION OF NITROGEN AND HOW CHEAP NITRATES WOULD REVOLUTIONIZE OUR ECONOMIC LIFE

How is Atmospheric Nitrogen Oxidized?

IT is not many years ago (1898) that Sir William Crookes sounded the note of alarm

concerning the possibility of a future famine in the world's supply of nitrates and other nitrogen compounds. At that time the supply of these salts was largely confined to certain beds of guano and Chile saltpeter. During the past few years most important advances have been made in our knowledge of the fixation of atmospheric nitrogen, and some of the processes have been placed upon a purely commercial basis.

In addition to drawing on the air directly for nitrogen it has been found that large amounts of ammonia and other nitrogen compounds may be obtained as by-products from coal and peat in connection with the manufacture of coke, illuminating gas and the metallurgy of iron. The treatment of various shales, peats, silts and organic refuse often yields nitrogen compounds. The nitrogen in these substances has probably been derived from the atmosphere by one or more of the processes which will now be described.

The amount of nitrogen that enters into the plant and animal growth ("nomadic" nitrogen) has been estimated to be about 20 gm. per square yard of land. Part of this is being constantly changed into nitrogen gas by the action of nitrifying and dentrifying bacteria. In nature an equilibrium is maintained between the action of these bacteria and the oxidization of nitrogen in the air by means of electrical discharges and the action of plants, such as clover. The natural processes of fixing nitrogen are therefore electrical and by the action of bacteria in the legume crops of clover and similar plants. In former geological times certain nitride and other chemical compounds may have been formed directly with the air nitrogen, but it is doubtful if any such direct chemical reactions take place at present.

The natural oxidation of nitrogen by electrical discharges takes place during electrical storms, the aurora discharges at high levels and possibly in a slight degree in the bombardment of the higher strata of air by cathode and similar rays, ultraviolet light, and possibly by other radiations. The disintegration of radium and thorium products yields a small amount of oxides of nitrogen. It has been estimated that in this way about 100,000,000 tons of fixed nitrogen is carried to the earth every year by rain water.

The other natural method of fixing atmospheric nitrogen is that of the action of bacteria in the root nodules of the clovers, peas, vetches and other legumes. The chemical processes are very complicated and are at present unknown. This process is, however, of tremendous importance to the farmer and is probably the cheapest method now known of obtaining nitrogen as a fertilizer. This method is, however, quite expensive in that clover seed is expensive and the raising of a crop of clover requires attention, time and the exclusion of other crops. On the poor soils where humus is the most needed it is found very difficult to get clover to grow. Restoration of fertility to run down soils by this method is therefore slow and expensive.

The commercial methods of manufacturing nitrogen salts includes the cyanamide process, the direct synthesis of ammonia, the various nitride processes of making ammonia and the electrical methods of oxidizing nitrogen.

A process that is being used commercially is that of treating calcium carbide with nitrogen gas, thus yielding cyanamide which itself makes a good fertilizer. Although the reactions are known to be complex, they may be represented as regards the end products as follows:

$$CaO + 3\ C \rightleftharpoons CaC_2 + CO,$$
$$CaC_2 + N_2 \rightarrow CaCN_2 + C.$$

The latter reaction begins at 1000° C. or at even lower temperatures. The N_2 may be prepared by the Linde process or by passing air over hot copper. According to Caro the energy consumption for fixing one ton of nitrogen (including making the CaC_2, azotising, machine driving, grinding, charging, air liquefaction) is less than 3 H.P. years.

The direct combination of nitrogen and hydrogen into ammonia is very successful when done on a small scale with pure gases but, so far as is generally known, this process is not being worked on a large scale. A Ger-

man company, however, is planning to make large quantities of ammonia by this process.

The nitride (including the Serpek) processes have not as yet proven to be successful from the commercial point of view. It is quite possible that these methods may be used in connection with the manufacture of aluminium and other metals with which these chemical methods are intimately connected.

The Electrical Methods for Fixing Nitrogen

Several electrical methods are used for oxidizing the nitrogen of the air into nitric acid and various salts of nitrogen. These methods all produce chemical reactions between gaseous oxygen and nitrogen in intense electric fields. Potential differences of thousands of volts are used and in the arc methods large currents and high temperatures accompany the use of intense electric fields. In all these methods the aim is to have the electrical discharge take place in the gaseous oxygen and nitrogen and to eliminate as much as possible the effect of the metallic electrodes. Large arcs are therefore necessary when the electric current is large. In the Birkeland-Eyde method the arc is drawn out by a magnet; in the Schönherr process by a helical current of gas and in the Pauling process by horn electrodes and currents of gas. In the author's method a corona current is used and this seems to give the most perfect type of a purely gaseous discharge.

The various electrical processes give about the same order of efficiency when this is measured by the number of grams of nitric acid produced per kilowatt hour of consumption of electrical energy. About 60 to 80 gm. of nitric acid are formed per hour per kilowatt of electrical energy.

The Complexity of Chemical Reactions

Although single atoms, ions and possibly molecules have been isolated, the condition under which the isolation takes place is entirely unique, the particles traveling with a very great velocity. In general chemical reactions will not take place under these conditions in any way that they can be studied individually. Our knowledge of chemical reactions is therefore entirely statistical and our laws apply to a very large number of reactions. There are numerous instances where experimental evidence indicates that the chemical reactions are frequently complex. The speaker's work on the absorption spectra of uranyl and uranous salts indicated the possible existence of various intermediate compounds in chemical reactions in solutions.

In gases chemical reactions are undoubtedly much less complex than they are in solutions, although here the reactions may not be as simple as they are sometimes represented. The spectroscope is beginning to show indications that the light centers are more numerous than the possible number of atom, ion and molecule types. In the case of nitrogen we have various types of line spectra and quite recently Grotrian and Runge[1] have made convincing claims that the so-called cyanogen spectrum is due to nitrogen. (These experimenters worked with large Schönherr arcs about a meter in length.)

Chemical Reaction Centers

Under conditions such as exist in the arc, spark or whenever the temperature is high, many kinds of "centers" may exist. These "centers" may be the sources of light and heat emission or absorption, the ions that show deflections by electric and magnetic fields, and the particles that take part in chemical reactions. It must not necessarily be assumed that the "centers" of the various physical phenomena are the same. They may be widely different.

Among the centers which may exist in arcs and sparks and which have been shown to exist in vacuum tubes are

$$\overset{-}{O}_2,\ \overset{-}{O},\ \overset{+}{O},\ \overset{+}{O}_3,\ \overset{\cdot}{O}_6,\ \overset{++}{O},\ O,\ O_2,$$

$$\overset{++}{N},\ \overset{+}{N},\ \overset{+}{N}_2,\ \overset{+}{N}_8,\ \overset{+++}{N},\ N,\ N_2.$$

Negative electrons also exist in comparatively large numbers.

The formation of nitric oxide in the electric discharge may take place in a large number of

[1] *Phys. Zeit.*, June 1, 1914.

ways. Some of these possible chemical reactions are as follows:

$$O\left\{\begin{array}{ll} + N + e + e + e = NO & (1) \\ + N = NO & (2) \\ + \overset{++}{N}_2 = NO + N & (3) \\ + \overset{+}{N} + e + e = NO & (4) \\ + \overset{+}{N} + e = NO & (5) \\ + \overset{+}{N}_2 + e = NO + N & (6) \\ + \overset{+++}{N}_3 + e = NO + N_2 & (7) \end{array}\right.$$

$$\overset{+}{N}_2 + \overset{-}{O}_2 = 2NO.$$

In the place of O we might place O_2, $\overset{-}{O}_2$, $\overset{-}{O}$, O, O_3, $\overset{+}{O}_6$ and $\overset{++}{O}$. We thus have 56 possible chemical reactions to represent the fixation of nitrogen. No doubt only a few of these reactions actually take place though all are possible, provided all these kinds of ions exist where the oxides of nitrogen are being formed.

The comparative probability of some of these reactions is very small, especially when more than two products take part in the reaction. Since the oxides of nitrogen are apparently not removed from the gases by the electric field, it is probable that the oxide of nitrogen centers are not charged. Hence it follows that reactions which involve the presence of an electron are improbable. The apparent fact that the reaction is "electrical" would indicate that the reactions $N_2 + O_2$ and $N + O$ are not probable. The latter is in accord with the view that active nitrogen consists of N and that N does not take any active part in the formation of oxides of nitrogen.

It seems quite probable therefore that the main reaction that results in the formation of oxides of nitrogen is

$$\overset{+}{N}_2 + \overset{-}{O}_2 + 43000 \text{ calories} = 2NO$$

This type of ionization is produced by cathode rays or rapidly moving electrons according to Thomson and others and accordingly this equation would indicate that the oxidization of nitrogen is indirectly due to cathode rays. It may be for this reason that thermionic electron radiations may play an important rôle in the formation of oxides of nitrogen in the various arc processes. In contrast to the above reaction is the reaction resulting in the formation of ozone. Ozone must necessarily be formed under conditions where some O_2 is dissociated.

The above reaction may be only one of several reactions, and under different conditions of pressure and temperature these reactions may be of relatively quite different degrees of importance.

Efficiency of the Nitrogen-fixing Process

We can get some idea of the inefficiency of the present methods of oxidizing nitrogen when we consider that when gram molecular weights of the gases are used one has:

$$N_2 + O_2 + 43{,}000 \text{ calories} = 2NO$$

approximately. The amount of energy used in this reaction is therefore about $1.7(10)^{12}$ ergs for about 126 gm. of nitric acid. Assuming 80 gm. of nitric acid to be made per kilowatt hour, we should have an energy consumption of about $5(10)^{13}$ ergs or an efficiency of about 4 per cent.

Nitrogen Fixation and Our Economic Life

The small percentage efficiency of the present methods for oxidization compared with the theoretical efficiency indicate that improvements in the present methods would yield most important results. At the present time sodium nitrate sells for about $45 per ton. If the efficiency of the oxidation method could be increased so that calcium nitrate could be sold for $6 or $8 per ton, it would change our economic life fundamentally. Food products would be greatly decreased in value, real intensive farming could be pursued, suburban homes could easily be made self supporting and "abandoned" farms could be reclaimed. Probably no other one scientific development would so materially add to the material well being of the people as this.

One of the reasons for the high cost of living is the fact that our soil fertility is difficult to maintain. Continued cropping will eventually impoverish the most fertile soils if the crops are not replaced. Cheap nitrogen fertilizers will not only practically restore virgin fertility, but will permit of the continual

removal of crops. In this way the percentage of the crops that can be removed from the soil will be very much greater than under present conditions.

The cheapening of nitrogen fertilizers will permit of doubling, trebling or even more greatly increasing farm crops. In addition to these results cheap nitrogen fertilizers will permit a very much greater percentage of crops to be removed from the farms. Cheap nitrogen fertilizers will also permit of the most intensive farming in the immediate vicinity of industrial centers, thus lessening the time and cost of food distribution.

Surely the problem of nitrogen fixation should appeal to every one interested in the conservation of our resources. Our waterfalls represent an equivalent of nitrogen salt continuously going to waste instead of being used. And surely work of this kind is of greater importance than the building of dreadnaughts or the training of armies.

W. W. STRONG

GARBAGE INCINERATOR AT BARMEN, GERMANY

OWING to the great distance garbage had to be hauled for dumping, the city of Barmen, numbering 172,000 inhabitants, formerly experienced considerable difficulty and inconvenience in disposing of its refuse and waste matter, and finally decided to build a garbage incinerating plant where waste material of all sorts is now burned.

The plant was constructed in 1907 and has given excellent satisfaction in every particular. Not only is all city garbage disposed of in a sanitary way, but from the cremation of this waste two important products are gained, an excellent quality of sand, and electricity.

The city's garbage is collected by an average of twenty wagons, which convey the same to the incinerator and there dump it into large bunkers measuring 4×12 meters (floor space) each. There are seven of these bunkers, each having four trapdoors to receive garbage. From the bunkers the garbage is carried on wheelbarrows to huge funnels which feed the furnaces where the refuse is burned. These funnels have a capacity of 1,200 lbs. each and they are also seven in number. After being filled, a large plug in the center of the funnel is raised and the garbage falls through the opening beneath into the furnace, where it remains for an hour. During the first half hour it rests in the rear of each furnace, where it is ignited by the former deposit, and after burning for half an hour it is brought to the mouth of the furnace by large iron scrapers manipulated by the men serving the fires, and there remains the rest of the hour, cooling and igniting the next deposit from the funnel.

The garbage is then in the form of a glowing, molten mass, called slag, which is removed from the furnaces with long iron hooks and is pulled directly from the grate into metal wheelbarrows, to be then wheeled to the sprinkling quarter, where the redhot slag is cooled by means of water sprinkled thereon for fifteen minutes. Later this process will be simplified, the slag being dipped into reservoirs instead of sprinkled.

After sprinkling, the slag resembles large clinkers and these now come to the crusher where they are broken, ground, and finally reduced to various grades of sand which is used with splendid results for building purposes and for the construction of bricks.

While the garbage itself is thus reduced to sand, the burning of the same gives another very valuable product, namely electricity. This is manufactured in the following manner. The gases resulting from the burning of the garbage have a temperature of from 1,200 to 1,500 degrees Celsius. These gases are conducted to two boilers and there utilized in the production of steam, the latter having a pressure of 10–12 atmospheres. Normally steam of this pressure has a temperature 180° Celsius, but in this case the steam is superheated until its temperature is 300° C., in order that it may be perfectly dry and there may be no danger of its injuring the turbine to which it is now conducted. This steam turbine is a 600 h.p. machine of 3,000 revolutions per minute, and its axle is directly united with that of the dynamo. The capacity of the latter is 400

kilowatts. The steam, consequently, after being heated to 300° Celsius, drives the turbine, and this, in turn, impels the dynamo which makes the electricity. After passing through the turbine, the steam is cooled in a condenser and is then pumped back into the boilers.

The electricity thus manufactured is sold to the municipal electric works (*i. e.,* owned and controlled by the city) at 3½ pfennigs (less than one cent) per kilowatt hour, and the electric works in turn sell the same to the public at 11 pfennigs (2.718 cents) per kilowatt hour. Whenever the garbage incinerator requires electricity for its own use, as for lighting, etc., on Sundays and holidays (ordinarily it furnishes its own electricity), it is obliged to procure this from the municipal works at the regular price of 11 pfennigs. Inasmuch as the garbage cremating plant is also a municipal institution, there eventually is not much advantage or disadvantage either way, as the money belongs to the city under any circumstances, the only difference being in the showing made by the various departments.

The garbage which is thus utilized for the manufacture of commercial products is practically every manner of refuse in existence: rags, paper, household waste, old clothing, and in fact every sort of material usually consigned to the dump heap.

From the garbage brought to the cremating plant 50 per cent. in weight and 30 per cent. in volume goes into the finished product, the sand. That is to say, 100 lbs. of garbage will produce 50 lbs. of sand, while from 100 cubic meters of garbage 30 cubic meters of sand will result.

When once started, the furnaces remain in operation uninterruptedly. The men performing the labor about the plant work in two shifts, from 6 A.M. until 2 P.M. and from 2–10 P.M. At that hour the last charge of garbage is banked so as to burn until the next morning. There is no coal or coke fire of any description, the garbage being its own and only fuel.

The efficiency of the Barmen incinerating plant lies chiefly in the construction of the furnace grates, these being V-shaped, but rounded at the base, and constructed from heavy cast iron. Along the sides of each grate are grooves in which are found minute holes at intervals of about three inches. Through these small holes a strong air current strikes the burning garbage, thus furnishing the necessary draft for combustion and aiding the process of cremation to a considerable extent. In other furnaces these holes are at the bottom of the grates and the wind reaches the fire from below, but it has been found that in this case the application of the air current is a too local one, not reaching the entire burning surface and often merely blowing through the fuel. By the Barmen method the air current, forced into the furnace by powerful pumps, strikes the burning garbage from the sides and from above at an angle, and together with the differing shape of the grate and the grooved sides thereof this method has proved most efficient.

The annual production of the plant amounts to 11,000 tons of slag or clinkers (which are crushed into sand as above explained) from 22,000 tons of garbage, while 1,700,000 kilowatt hours is the annual output in electricity.

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SPECIAL ARTICLES

A POSSIBLE MENDELIAN EXPLANATION FOR A TYPE OF INHERITANCE APPARENTLY NON-MENDELIAN IN NATURE

As research in genetic problems proceeds, the work of many investigators shows that in all probability certain characters of the organism depend for their visible manifestation in the zygote upon the simultaneous presence of more than one mendelizing factor.

One of the classic examples of this condition is that of the inheritance of the walnut comb in fowls reported by Bateson[1] (1909,

[1] Bateson, W. (1909), "Mendel's Principles of Heredity," Camb. (Eng.) University Press.

p. 60). The chief point of interest in this investigation was the fact that the simultaneous presence in the zygote of R, the factor for rose comb, and P, the factor for pea comb produce an entirely new character, namely, the *walnut comb.* Two walnut-combed birds produced by a cross of pea comb × rose comb gave, when crossed together, an F_2 progeny consisting of walnut, rose, pea and single comb, in a ratio of 9, 3, 3, 1.

A similar result would be obtained if the parents used in the original cross were walnut comb of the formula RRPP and single comb rrpp.

In this last case if we focus our attention on the walnut comb we should see that it recurred in approximately 9 out of 16 of the F_2 progeny.

A *character* dependent solely upon *one* mendelizing factor is present in three fourths of the F_2 progeny. The ratio of those lacking it to those having it being as 1:3. When, however, two factors are needed for the manifestation of a character, as in the case of the walnut comb, the character is lacking in a far greater number of F_2, namely, in 7 out of 16. The ratio of those lacking the character in question to those having it becomes 1:1.3 instead 1:3, as in the case involving only one factor.

If *three factors* are necessary for the manifestation of a given character, the F_2 ratio shows a still greater proportionate increase of animals lacking the character. If the simultaneous presence of factors A, B and C is necessary for the manifestation of a given character, the number showing the character in F_2 may be calculated as follows: F_2 will be made up of 27ABC, 9ABc, 9AbC, 9aBC, 3abC, 3aBc, 3Abc, 1abc. Only the 27 ABC animals will show the character question, and the ratio of those lacking the character to those having it will be as 1.3:1.

An actual cross of this sort is the following: a wild black agouti mouse having the factors B for black, A for agouti and D for intensity was crossed with a dilute brown mouse having the factors b for brown, a for non-agouti and dil for dilution.

F_1 animals were all Aa Bb Ddil, all of them having the character in question, namely, *intense black agouti pigmentation.*

When these F_1 animals are crossed together they should give a ratio of 27 intense black and 140 other colors, while the expected numbers obtained were 107 intense black agouti and 140 other colors, while the expected numbers are 105.3 intense black agouti and 141.7 other colors, respectively.

Another cross with mice recorded by Phillips and the writer[2] (1913) will serve to illustrate the case of four factors. Here the ratio expected is one animal having the character in question, to 2.16 lacking it.

From Table I.[3] it will be seen that there are in F_2 436 animals possessing the character in question (intense black agouti) to 744 lacking it, the expected numbers being 373 to 807.

As the number of factors increases, the ratio of animals which *do not* show the character to those that do increases rapidly.

With 10 factors it becomes 16.7:1, with 15 factors, 73.8:1, and with 20 factors 314.3:1.

It will be convenient to present this in tabular form as follows:

Number of Factors	Ratio of Animals Lacking Character to Those Having
1	1:3
2	1:1
3	1.3:1
4	2.1:1
5	3.2:1
10	16.7:1
15	73.8:1
20	314.3:1

The general principle involved is that, with the addition of each factor involved, the number of F_2 animals possessing the character in question is multiplied by three, while the *total* number of F_2 zygotes is multiplied by four. It will be seen, therefore that the difference between the number of animals *with* the char-

[2] Little, C. C. (1913) and Phillips, J. C., "A Cross Involving Four Pairs of Mendelizing Characters in Mice," *Am. Nat.*, Vol. 47, pp. 760–762.

[3] *Loc. cit.*, p. 761.

acter and those *lacking* it grows progressively greater with each factor added.

The practical value of the principle may prove to be considerable as it serves to explain cases in which a character dominant in F_1 almost completely disappears in F_2, and in which an apparently non-mendelian result is obtained involving a reversal of dominance.

For supposing that a certain character, x, depended for its visible manifestation upon the simultaneous presence in the zygote of 20 factors which we may designate as A, B, C . . . T. Then if an animal possessing this character and the above mentioned factors is crossed with one from a race lacking all these factors, F_1 *would all be of the formula Aa Bb Cc . . . Tt. All would develop the character in question since all had a single representation of the twenty factors. If, however, these F_1 animals were bred inter se F_2 would give approximately only one animal in 314 which had the character in question.* If only a small number of F_2 were raised the character might well be thought lost and perhaps not truly inherited by F_1.

An entirely different result would, of course, be obtained if the factors in question needed to be present in *all* the gametes of the zygote in order for the character to be visibly manifested. In such a case as this none of F_1 would show the character, and its reappearance in F_2 would follow the ordinary rules of mendelian segregation and recombination.

This note is merely offered in the hope that it may be of use in the explanation, on a Mendelian basis, of certain results which might otherwise be offered as examples of non-mendelian inheritance.

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THE STRUCTURE OF THE COTTON FIBER

In any kind of cotton the typical fiber, that is the one in which all the essential parts may be determined, can be found in rare cases. For this reason the structure of an ideal fiber can be inferred only from a series of studies of fibers in successive stages of development.

By subjecting such fibers to certain chemical and bacteriological treatments and then studying them under the microscope, we found that the typical cotton fiber consists of the following parts:

1. The outer layer or the integument.
2. The outer cellulose layer.
3. The layer of secondary deposits.
4. The walls of the lumen.
5. The substance in the lumen.

1. *The outer layer or the integument* is the incrusting layer and forms the cementing material of the fiber. Its chemical structure is not an homologous one, but is a mixture of components, some soluble in alcohol, some in ether, and some in water. The components are cutinous, pectinous, gummy, fatty and other unidentified bodies.

2. The *outer cellulose layer* is in its structure a distinct spiral, consisting of a limited number of component fibers, perhaps of one or of two. The structure of this layer is determined under the microscope from a longitudinal section of the fiber after the latter has been subjected to a series of chemical and bacteriological treatments. Careful treatment of some of the fibers by cuprammonia will show under the microscope this spiral. There is some evidence to show that this spiral consists of impure cellulose.

3. The *layer of secondary deposits* seems to be made up of component fibers which in no case have shown a spiral structure. Unlike the fibers of the above described layer, these components are from about five to ten in number and run with some irregularities along the length of the fiber.

4. The structure of the layer forming the *walls of the lumen* is a spiral much the same as the outer spiral, but differs from it greatly in its chemical composition. This is determined from a microscopical study of the fiber while under a cuprammonia treatment.

5. *The substance in the lumen* is structureless and, as is proven by a microscopical test, is of a nitrogenous nature.

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SCIENCE

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Friday, December 25, 1914

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH

III. THE FUTURE OF THE NATIONAL ACADEMY OF SCIENCES[1]

In previous papers of this series[2] we have traced the development of European academies and observed the powerful influence they have exercised on the advancement of research; we have watched the beginnings of scientific investigation in the United States, and their public recognition by act of Congress establishing the National Academy of Sciences; and we have followed the history of the Academy during the half century which has elapsed since its origin. In view of the great part which academies have played in the past, and the fact that the rapid development of original research in this country has carried us out of the pioneer period, the National Academy now faces an exceptional opportunity to impress its influence upon the future scientific work of the United States. But if it enjoys an opportunity, it also faces a duty, imposed upon it by its national charter and by its position as the sole representative of

[1] This paper was presented at the Baltimore meeting of the National Academy in November, 1913. By action of the council, a manuscript copy was subsequently sent by the home secretary to each member of the academy for criticism and comment. In preparing the paper for publication, the author has had the advantage of seeing these replies. Except for a few minor verbal changes, the text is printed in its original form, with the addition of new paragraphs in square brackets.

[2] I. "The Work of European Academies," SCIENCE, 38, 681, 1913. II. "The First Half Century of the National Academy of Sciences," SCIENCE, 39, 189, 1914.

America in the International Association of Academies. The history of the Academy shows that it has taken its obligations seriously, by complying with requests from the executive and legislative departments of the government for advice on scientific matters, by the use of trust funds for the advancement of research, by the award of prizes and grants for investigation, by the initiation and support of international cooperation in research, and by such other means as its limited endowment has permitted. But while the rapid growth of the scientific bureaus of the government has reduced the number of questions which would otherwise be submitted to the Academy, the enormous increase in the wealth of the country, and the expansion of its trade relations have raised new problems and advanced new opportunities. These developments, which have resulted in the multiplication of universities, observatories and laboratories, and the foundation of great endowments for research, place the Academy in a new position, and impose the question whether it can not now accomplish much more than was formerly possible. It is the purpose of this paper to open the discussion of this question, in the hope that its further consideration by other members may lead to an extension of the work and usefulness of the Academy.

Fortunately we may take advantage of the rich store of experience accumulated by the European academies during their long histories. In seeking to adapt this to our own needs, we must of course recognize the special conditions existing in the United States. The great area over which our members are distributed and the lack of any such centralization as we see in London or in Paris, will always stand in the way of weekly meetings like those of the Royal Society and the Paris Academy. But if we can not hope to see our leading investigators personally demonstrate each step in their progress before academic audiences, as Faraday and Pasteur and many another have done abroad, we can nevertheless provide for lectures and papers illustrated by experiments in connection with the semi-annual meetings of the Academy, and possibly for others of a public character, extending throughout the year, after the manner of the Royal Institution of London. The disadvantage of our members in being unable to read accounts of their latest advances before weekly meetings of their colleagues can also be largely offset by the publication of *Proceedings,* in which the first results of all new work may be adequately presented. Thus, though we lack some of the advantages of centralization, these may be largely overcome, while retaining the very great advantage of a widely distributed membership representing the scientific interests of every section of the country.

FUNCTIONS OF A NATIONAL ACADEMY

The criticism has sometimes been directed against academies covering the whole range of knowledge that their place has been sufficiently filled by the special societies devoted to particular branches of science. For more than a century the Royal Society and the Paris Academy served all the purposes of science in Great Britain and France, but toward the end of the eighteenth century special societies began to develop in England. The establishment of the Linnean Society in 1788 did not appear to give special concern to the members of the Royal Society. But when the Geological Society was instituted in 1807, Sir Joseph Banks, then President of the Royal Society, united with Sir Humphry Davy and others in a strenuous attempt to amalgamate it with the parent body. The Royal Astronomical Society was established in

1820, partly as the result of the accumulation of valuable observations too extensive for the Royal Society to publish. Sir Joseph, though he had himself aided in the establishment of the Linnean Society, was greatly perturbed at this further development. A short time later he died in the belief that the special societies had struck a severe blow at the respectability and usefulness of the Royal Society, by robbing it of many of its members and laying claim to some of its most important departments.[8] But his fears were wholly unwarranted, and the special societies continued to grow and multiply, to the advantage of science and of the Royal Society itself. Their extensive publications have not detracted from the volume or the quality of the *Philosophical Transactions* and the *Proceedings,* and each of these societies, by contributing to the development of some special field, has helped to build up that great organization of British science of which the Royal Society is the acknowledged and venerated head.

These details will not be out of place if they help to emphasize a principle which should always be respected in the work of the National Academy. The societies and journals which have been established to meet the needs of scientific progress have come to stay. It is neither necessary nor in any way desirable to usurp their functions, which are the result of a natural process of evolution. There is ample room, however, for academies devoted to the whole range of science. The rapid advance of research in a thousand ramifying fields has left much intermediate territory unexplored. The approach to these undeveloped regions may be made from more than one direction, and through the aid of more than one method. Thus nothing can be more stimulating to the progress of research than an acquaintance with the investigations and processes which are constantly being developed in fields other than one's own. Mathematics has received its principal impulses from astronomy and physics. Physical chemistry is indebted, on the one hand, to Pfeffer the botanist for the study of vegetable cells, and on the other to the mathematical and physical investigations of Willard Gibbs, Van der Waals and Arrhenius. Astrophysics came into existence through the use in astronomy of the spectroscope and other physical instruments. Every department of science sheds a luster which should illuminate, not only its particular territories, but others, near and far, occupied by other workers. The importance of recognizing and utilizing this fact must therefore increase as time goes on.

[It has been truly said that an academy can hope to accomplish large results only as it succeeds in meeting the conditions of the present rather than those of the past. What are existing conditions in science? Surely none is more striking than the contraction of the field of the average investigator. Specialization is inevitable in the maze of modern progress, and the narrowing effect of constant devotion to a single subject must become still more apparent as science ramifies further. A general academy, by insisting on the importance of large relationships, by demonstrating the unity of knowledge, by recognizing the fact that fundamental methods of research, wherever developed, are likely to be applicable in more than one department, can do much to broaden and to stimulate its members. The correlation of research should be counted as one of its prime objects, and its energies should be largely directed to this important end.]

We are thus led to the conclusion that

[8] Barrow, "Sketches of the Royal Society," pp. 10, 256; Weld, "History of the Royal Society," pp. 242, 246.

the functions of a National Academy should be of the broadest character, and that the advantage of sharing in the results of all its departments should belong to every member. Thus the policy of our National Academy of avoiding division into separate sections,[4] and of bringing papers on the most diverse subjects before the entire body, is fundamentally sound and should be maintained. Later in this paper the question will be considered whether the range of the Academy's activities should be extended so as to give increased recognition to departments of knowledge other than the physical and natural sciences.

Under the conditions now existing in the United States, there is reason to believe that the functions of a National Academy might well be multiplied so as to meet a wide variety of needs. It should stand, first of all, as a leading source and supporter of original research and as the national representative of the great body of American investigators in science. To the government it should make itself necessary by the high standard of its work, the broad range of its endeavors, and the sane and scientific spirit underlying all of its actions. To its members it should offer stimulus and encouragement in their investigations; due recognition of their advances; financial assistance and the use of instruments at critical periods in their work; the advantage of listening to papers ranging over the whole field of science, bearing suggestions of principles or methods likely to develop new ideas; contact with the greatest leaders of research from all countries and opportunities to listen to descriptions of their work; access to books and manuscripts not easily obtainable from other sources; and participation in international cooperative projects in every field of investigation. In the public mind it should rank as the national exponent of science, and as the agency best qualified to bring forward and illustrate the latest advances of its own members and of the scientific world at large. To representatives of manufactures and industries, the Academy should serve to promote the appreciation and widespread use of the scientific principles and methods which have built up the great industrial prosperity of Germany. With other societies devoted to various branches of science, it should cooperate in harmony with the best interests of American research. Toward local bodies for the encouragement of investigation and the diffusion of knowledge, it should act as an inspiring example and a reliable source of support. And in the broad field of international cooperation, it should unite with the leading academies of the world in the endeavor to perfect the organization of research and in the use of all agencies contributing to its advancement.

[4] Except for voting purposes.

NEEDS OF THE ACADEMY

Many of these objects have been accomplished by the National Academy in the past, but others remain for the future. The greatest aid in accomplishing its full work would be met by the provision of a suitable academy building, and an endowment sufficient to publish *Proceedings*, conduct research, provide public lectures, maintain exhibits illustrating current investigations, and to meet such additional needs as are implied by the Academy's national charter and its obligations to the scientific world and the general public. Through the courtesy of the Smithsonian Institution, extended in the year of the academy's organization, the annual meetings are held in the National Museum, in rooms ordinarily employed for other purposes. Thus the Academy does not even possess a permanent office, or a room for its library, which will

be needed in the future for its work of research. It has therefore been compelled from the outset to decline many offers of books, and thus a large and valuable collection, comprising publications offered by many of the great academies, laboratories and observatories of the world, has been lost.[5]

It is difficult to overestimate the value of a suitable building in commanding public appreciation and support for any institution. Visible evidence of the Academy's existence is a matter of no small importance, when it is remembered that the average American citizen, though well-acquainted with the name of the Paris Academy through press reports of discoveries announced there, has never heard of our own national organization. But a building used as a storehouse and occupied but once a year is not enough. The Academy must be known as a living and active body, which recognizes and fulfills its many duties to science and the public. If its headquarters were constantly employed for such purposes as are enumerated later, the Academy would soon be looked upon as the natural source of information regarding the latest developments of science, and more generally recognized as the national representative of American research.

IMPORTANCE OF PUBLISHING PROCEEDINGS

As explained in a previous paper, the name of the National Academy has never been associated with the work of its members, since the papers read at its meetings have not been published by the Academy. Thus it has not been sufficiently identified with the progress of American research, and the chief source of the reputation of the Paris Academy and the Royal Society has been lacking. But though the Academy would become more widely known by the publication of *Proceedings*, it would be foolish to take such a step merely to accomplish this purpose. The establishment of a new journal, in these days when the literature of science has become exceedingly complex, should never be undertaken without serious consideration of its probable usefulness. If it fulfills no good and lasting purpose, its life will be deservedly short. Hence we may not imitate the example of societies which established their publications before the special journals had taken the field. We must recognize, on the one hand, that the various journals devoted to particular branches of science meet a clearly defined need and should not be rivaled, even to the apparent advantage of the Academy. On the other hand, we must also remember that the members of the Academy have adopted a regular plan of publication, the interruption of which might interfere with the accessibility of their papers. Thus, if *Proceedings* are to be established, they should be so planned as to serve a useful scientific end and be distinctly advantageous, not merely to the Academy itself, but to all of its members.

I am strongly of the opinion that no step which can be taken at the present time would be so beneficial to the National Academy as the publication of *Proceedings* containing the first announcements of important advances and the chief results of American research. I believe, furthermore, that this can be done in such a way as to benefit the members and contribute to the advancement of science. In many departments of the Academy's work papers published in the special American journals of limited foreign circulation do not reach a sufficiently large group of European readers. I am told that this is

[5] The Academy has accepted some gifts of books, which are packed away (unbound) in the storerooms of the Smithsonian Institution.

particularly true in biology, where American investigators are producing a great body of results of the first importance. Thus the *Proceedings* of the Academy, if properly distributed, might be made to serve the very useful purpose of bringing the work of a large number of investigators to the attention of scholars abroad. But in order to preserve all interests, and to interfere in the least degree with present plans of publication, the *Proceedings* should not be designed to occupy such a place as the special journals adequately fill.

[The chief advantage of the *Proceedings* would not be the same in all departments of science. In mathematics, where the existing journals are greatly overcrowded, prompt publication of the condensed results of new research would be heartily welcomed. The same thing is true in botany and in many other subjects. In fact, improved means of prompt publication would be generally appreciated by Academy members. In biology, as already remarked, the great number of special journals prevents many of them from reaching European laboratories, where American research is frequently overlooked as a consequence. In astronomy and astrophysics, which have fewer journals, the circulation of the chief American journals is large, and their contents reach all investigators abroad. But the practise of publishing separate series of circulars or bulletins, which has been adopted by many American observatories, confines the circulation of their papers to the limited number of astronomers and observatories on their mailing lists. If brief accounts of the broader aspects of these investigations were printed by the Academy, they would be useful to astronomers making a general survey of progress in their own field. But they would be even more serviceable to the mathematician, physicist, meteorologist, chemist, geologist or other investigator who may find information of direct or suggestive value in the results of astronomical research. Conversely, even those astronomers who keep in touch with progress in mathematics or physics can not also examine the numerous journals of chemistry, geology and other subjects which contain results applicable in their own work. It will thus be seen that the Academy could perform an important service in its special province of correlating knowledge by publishing papers covering the whole range of science.

The value of the *Proceedings* in strengthening the position of American science at home and abroad should not be overlooked. The rapid progress of American research in a single field may be known to the European specialist, but he may not realize that similar advances in other departments have raised American science to a new level. Recognition of this fact is desirable, not for the gratification of national pride, but because the international influence of America in science will grow with its prestige. The combination of effort which the *Proceedings* would represent, and the demonstration they would afford of American activity in research, are factors of real significance in securing that recognition and standing, both at home and abroad, which is needed to accelerate future progress.]

To accomplish the desired result, it would seem that the *Proceedings* should be intermediate in character between the *Comptes Rendus* of the Paris Academy and the *Proceedings* of the Royal Society. Papers read before the Paris Academy on Monday are printed and issued in the *Comptes Rendus* on the following Saturday—a record for speed which we should not expect to rival. Such accelerated publication, while it doubtless possesses certain advantages, renders impossible that more leisurely

editorial examination which most journals demand. The *Proceedings* of the Royal Society, on the other hand, appear at irregular intervals, and frequently contain long and detailed papers, which with us might better find a place in the special journals. In the case of the National Academy it is doubtful whether publication at shorter intervals than one month is necessary, but the possible advantages of fortnightly publication should be carefully considered.

It goes without saying that papers for the *Proceedings*, while comparatively brief (perhaps averaging from three to five pages), should not be hasty announcements based on inadequate data. On the contrary, the dignity of the National Academy and the best interests of its members demand that only carefully matured conclusions, resulting from prolonged observational or theoretical research, should appear under the Academy's imprint. Measures and other exact data needed to establish these conclusions would be a necessary part of such papers, though long numerical tables, profuse illustrations, and detailed accounts of minor topics should be reserved for publication in the special journals, to which members would continue to contribute as before. The Academy *Proceedings* would thus serve for the first announcement of discoveries and of the more important contributions to research, illustrated by line cuts and occasional halftones in the text, when essential to clearness, but free from unnecessary detail and extensive numerical data. Non-members, as well as members, should be invited to contribute, with the understanding that their papers are to be presented by a member of the Academy, as in the case of the Paris Academy and the Royal Society.[6]

The constitution of the National Academy already provides for the issue of *Proceedings*, as well as *Memoirs* and *Annual Reports*. In fact, as explained in a previous paper, three volumes of *Proceedings* were published, though they did not contain papers presented to the Academy. There is therefore no need of any radical departure requiring amendment of the constitution. In other words, if sufficient funds are available, this very important step toward the development of the Academy can be taken by simple affirmative vote.[7]

The annual volumes of the *Proceedings*, bringing together for the first time the best product of American research, would place the Academy in a clearer light before the academic world. *Annual Reports* and infrequent volumes of *Memoirs* receive scant attention, except from a few specialists, in the libraries of our contemporary societies. But the *Proceedings*, published at regular intervals, and containing a standing notice of the Academy's publications, would aid in making them better known. The quarto *Memoirs*, eleven volumes of which have already appeared, afford an excellent place for extended publication, when the necessity for lengthy tables, numerous plates, or long discussions of data places the manuscript beyond the reach of the special journals. The publication of the *Proceedings* might serve to disclose

[6] The *Proceedings* should be so planned as to interfere in the least possible degree with the *Journal* of the Washington Academy of Sciences, which is a publication similar in character to the one here proposed. As the *Journal* is devoted mainly to work done in Washington, or presented before the various Washington societies (other than the National Academy), no important overlapping of the two publications need be anticipated, especially as members of this Academy have rarely contributed to the *Journal*.

[7] [The Academy voted, at its meeting of November, 1913, to begin the publication of *Proceedings* as soon as arrangements could be perfected. The first number will appear in January, 1915.]

much material worthy of use in the *Memoirs*, and the editorial board should be constantly on the watch for opportunities to extend the *Memoirs* and to render them more serviceable to science.

SCIENCE AND THE PUBLIC

The circulation of the *Proceedings* would necessarily be limited to scholars and scholarly institutions—they could not be expected to reach the general public. Here a difficulty remains to be overcome, since the results of original investigations should certainly be made more generally known and more clearly understood than they are at the present time. The average man of science, after sad experience with the daily press, is usually forced to the conclusion that newspaper publication is synonymous with rank sensationalism. Repeatedly told, and not without justice, that his cloistered wisdom should reach a wider world, he sometimes yields to the persistent demands of a reporter. The outcome is too well known to require telling. Even in the case of a really intelligent and conscientious reporter, who does not distort or exaggerate, the "headline man" may be depended upon to provide a grotesque disguise. A few experiences of this sort suffice for most investigators. They are soon forced to shut out the reporter, and are well pleased when they succeed. Yet they recognize that the exclusion of the public from all contact with their work is neither fair nor desirable. Some way should be found of bridging the gap.

A plan followed in England by the Royal Society, of circulating brief abstracts on the day when a paper is read, which are afterwards published in *Nature* (sometimes in condensed form), is one which we might advantageously imitate. When a paper is accepted by the editorial board for publication in the *Proceedings*, a brief abstract, preferably prepared by the author, should be sent to SCIENCE (and perhaps also to *Nature*). At the same time this abstract, or a briefer one in less technical language, might be communicated to the Associated Press. It goes without saying that papers for the *Proceedings* would differ widely in their availability for popular treatment. Probably only a comparatively small proportion of them would contain results suitable for use by the Associated Press, but all would doubtless be published in abstract by SCIENCE. Through the Associated Press, and also through certain conservative newspapers and magazines, the Academy could thus bring before the public the actual results of scientific research, as distinguished from the false and distorted conceptions of science which most of our newspapers now disseminate.

LECTURES ON RESEARCH

The plan of publication outlined above is but one of several methods by which the Academy may enlarge its usefulness. Public lectures should also be instituted, primarily for the benefit of the Academy members, but also with the expectation of reaching a larger circle. Here the Academy would do well to study and imitate the Royal Institution of London, where original research and the diffusion of knowledge are combined in a very effective manner. In brilliant addresses, illustrated by lantern slides and experiments, a long line of illustrious speakers, best typified by Faraday, have charmed and enlightened the most distinguished audiences. Many of these speakers, including Davy, Faraday, Tyndall, Dewar, Rayleigh and Thomson, have been drawn from the staff of the Royal Institution. But their English contemporaries, as well as scientific men from all parts of Europe and the United States,

have also been invited to describe their latest advances. The speaker at a "Friday Evening Discourse" is faced by the leaders of English thought and action in many fields. Privileged to select from the large collection of historic instruments accumulated during a century, and even to illustrate his points with the apparatus of Faraday himself, he feels an inspiration that no other platform affords. In such an atmosphere he learns to appreciate the dignity of popular science at its best, and to perceive how the busiest and most successful of present-day physicists can find time to deliver elaborate courses of Christmas lectures to a juvenile audience. These lectures, instituted by Faraday, are now in their eighty-seventh season. Under such topics as "The Chemistry of Flame" they have afforded him and his followers an opportunity to show how simply and beautifully the principles of science can be made to appeal even to young children.[8] The art of the popular lecture should be developed in the United States by the National Academy. Under its auspices, and with the example of the Royal Institution behind him, the lecturer need not fear for his dignity. The Academy would soon find its reward in the increasing appreciation of its work and purposes, the spread of scientific knowledge, and ultimately in larger endowments for research.

As a first step in this direction, the children of the late William Ellery Hale have established a course of lectures in memory of their father. Their object in doing so is twofold. In the first place, it is hoped that the lectures may add to the attractiveness of the Academy meetings, both to the members and the public. Again, it is believed that by a suitable choice of lecturers and topics, the inter-relationship of the various fields of research represented in the Academy, and the light thrown by the methods of investigation or of interpretation employed in one field upon those of another, may be illustrated in an effective way. Moreover, the lectures will afford an opportunity of testing whether the Academy may not further assist in increasing public appreciation of the cultural and the industrial value of science.

SCIENCE IN EDUCATION

In the Academy of Plato and the Alexandrian Museum the functions of an academy and a university were united, and the work of instruction went hand in hand with the development of new knowledge. The growth of the modern university has now removed from national academies their former work of teaching a body of students, but their opportunity to exert a favorable influence on the educational methods of the nation remains. The Institute of France, as planned by Talleyrand and Condorcet,[9] was to control public instruction and offer courses to advanced students. This was not carried out, but an instance of the same sort is afforded by the Academy of Munich, which has charge of the public instruction of Bavaria.

There is no apparent reason why our own National Academy should have a formal connection with educational institutions. But in harmony with its purpose to advance knowledge in the United States, it should contribute toward the development of the science of education and take advantage of the possibility of increasing public appreciation of the educational value of science.

In a presidential address which excited

[8] The last course of Christmas Juvenile Lectures, on "Alchemy," "Atoms," "Light," "Clouds," "Meteorites" and "Frozen Worlds," was given by Sir James Dewar.

[9] See Hippeau, "L'instruction publique en France pendant la révolution," Vol. 1, pp. 115, 228.

great public interest in England, Sir William Huggins emphasized before the Royal Society the importance of science in education.[10] We need not dwell upon his arguments regarding the value of scientific training in developing the power of accurate observation and the habit of correct and cautious reasoning. But a more neglected phase of science in education—its power of awakening and expanding the imaginative faculty—may be referred to in his own words:

> Surely the master-creations of poetry, music, sculpture and painting, alike in mystery and grandeur, can not surpass the natural epics and scenes of the heavens above and of the earth beneath, in their power of firing the imagination, which indeed has taken its most daring and enduring flights under the earlier and simpler conditions of human life, when men lived in closer contact with Nature, and in greater quiet, free from the deadening rush of modern society. Of supreme value is the exercise of the imagination, that lofty faculty of creating and weaving imagery in the mind, and of giving subjective reality to its own creations, which is the source of the initial impulses to human progress and development, to all inspiration in the arts, and to discovery in science.

Of all the teachings of science, the principle of evolution makes by far the strongest appeal to the imagination. Isolated phenomena, however remarkable, acquire a new meaning when seen in its light. Minute details of structure in animals or plants, slight differences of the relative intensity of lines in the spectra of stars, may become of intense interest even to the elementary student if explained as steps in a great process of development. But, after all that has been said and written since the time of Darwin, we fail to take full advantage of our opportunity. Properly presented, a picture of evolution in its broadest aspects would serve better than any other agency to stimulate the imagination, to awaken interest in science, and to demonstrate that its cultural value is in no wise inferior to that of the humanities. To the average student, even physics and chemistry are distinct branches of science, each occupied with its own problems. Astronomy, he knows, concerns itself with the heavenly bodies, botany with plants, zoology with animals. But if he studies these subjects at all, he almost invariably fails to realize their relationship, because no binding principle, like that of evolution, is brought prominently to his attention or, at the best, is restricted in its application to some single organic or inorganic field.

When Humboldt wrote "Cosmos" and Huxley lectured on "A Piece of Chalk" and other subjects, they showed what might be accomplished in picturing the problems of science in a broad way. The National Academy is better qualified than any other body in America to demonstrate what can be done in the same direction with the rich store of knowledge acquired since their time. A course of lectures on evolution, beginning with an account of the constitution of matter, the transformation of the elements, and the electron theory; picturing the heavenly bodies and the structure of the universe, the evolution of stars and planets, and the origin of the earth; outlining the various stages of the earth's history, the formation and changes of its surface features, the beginning and development of plant and animal life; explaining modern biological problems, the study of variation and mutation, and the various theories of organic evolution; summarizing our knowledge of earliest man, his first differentiation from anthropoid ancestors, and the crude origins of civilization; and connecting with our own day by an account of early Oriental peoples, the rise of the Egyptian dynasties, and their influence on modern

[10] Huggins, "The Royal Society," p. 109.

progress: such a course, free from technicalities and unnecessary details, richly illustrated by lantern slides and experiments, and woven together into a clear and homogeneous whole, would serve to give the average student a far broader view of evolution than he now obtains, and leave no doubt in the hearer's mind as to the cultural and imaginative value of science.

The William Ellery Hale lectures will open with a series on evolution, so designed as to be of interest to members of the academy, and at the same time to be intelligible and attractive to the public. At each meeting two lectures will be given by a distinguished European or American investigator, chosen because of his competence to deal with some branch of the subject. The first course of lectures, to be given by Sir Ernest Rutherford at the annual meeting in April, 1914, will deal with the constitution of matter and the evolution of the elements.[11] At the conclusion of this series, which will extend through several years, it is hoped that the lectures may be brought together, in a homogeneous and perhaps somewhat simplified form, into a small volume suitable for use in schools.

The course above outlined will serve to test the question whether the Academy may advantageously enter more extensively into the lecture field. So far as the members of the Academy are concerned, it seems probable that lectures by able American and European investigators would add to the interest of the meetings. But the value of the lectures to the general public can only be determined by experiment. If a suitable building can be obtained, and the success of these lectures is sufficient to warrant it, the foremost investigators, American and foreign, might be invited from time to time throughout the year to describe and illustrate their advances in the lecture-hall of the Academy. This plan is already followed by various American institutions, but the Academy, because of its national character, would be better able to attract the best men and to give their lectures more than local significance. Ample facilities for experimental illustration would also go far toward enhancing the value of the lectures. In short, the example of the Royal Institution should be followed as closely as possible.[12]

INDUSTRIAL RESEARCH

The value of science to the American manufacturer, though no new theme, is capable of wide development at the hands of the National Academy. In a presidential address delivered before the Royal Society in 1902, Sir William Huggins dwelt on the "Supreme Importance of Science to the Industries of the Country, which can be secured only through making Science an Essential Part of all Education." He saw the fruits of English discoveries passing into the hands of Germany, whose universities have so long fostered and spread abroad the spirit of research, and wondered at the apathy of the average British manufacturer toward scientific methods. Huggins, speaking in plain language, pointed to the chief source of weakness—"the too close adherence of our older universities, and through them of our public schools, and all other schools in the country downward, to the traditional methods of teaching of medieval times."[13]

In this country, where the classics do

11 [The second course was given at the autumn meeting by Dr. William Wallace Campbell on "Stellar Evolution and the Formation of the Earth."]

12 [It has been suggested by several members that these lectures might be repeated in two or three large cities, in cooperation with local scientific institutions.]

13 "The Royal Society," p. 29.

not dominate the university system, the task of arousing an adequate appreciation of the enormous benefits which science can render is a far easier one. We must have, first of all, a widespread interest in science and some comprehension of its problems and methods. A general course on evolution, given to all college students, should be of great service as an entering wedge. More students might thus be led to take science courses, while those who specialize in the humanities could gain a better conception of what science means. The rapid development of research in our universities and technical schools promises to influence the faculties of our colleges, where a man's success as a teacher will be materially enhanced if he is also a producer of new knowledge. Thus the future is promising in the educational field.

On the side of our manufacturers, who are eager to adopt the most efficient methods, the outlook is equally favorable, as President Little of the American Chemical Society showed so effectively in his address on "Industrial Research in America."[14] Many great firms are establishing large research laboratories, where problems of all kinds are under investigation. The development within the past few years of Taylor's efficiency system is another indication that the advantages of scientific methods are being grasped and applied in the arts. But the opportunities in this direction are almost endless, and the National Academy would do well to devise ways and means of convincing not only the large manufacturers, but the small manufacturers as well, of the industrial importance of scientific research. Lectures on recent advances in engineering, by European and American leaders, should have a powerful influence if carefully planned and effectively illustrated. Parsons on the steam turbine,[15] Marconi on wireless telegraphy,[15] Goethals on the Panama Canal, would attract large audiences and appeal in published form to a wide public.

But while the advantages resulting from ingenuity and invention and the best practise of engineering should certainly be brought out in the course of lectures I now have in mind, the improvement of manufactured products by research methods, and the potential industrial value of pure science are the points which should be emphasized. We have a long way to go before any single manufacturing firm employs seven hundred qualified chemists, as the combined chemical factories of Elberfeld, Ludwigshafen and Treptow do. The supremacy in this field of Germany, which produced chemicals valued at $3,750,000,000 in 1907, is directly due to the carefully directed research of an army of chemists, who learned the methods of investigation in the universities and technical schools.[16] The Berlin Academy of Sciences has also contributed in an important way to this result, through van 't Hoff's investigations of the Stassfurth salt deposits. The recent rapid development of our own chemical industries leads us to hope that similar advances may soon be achieved in the United States. In electrical engineering, at least, we are already making comparable progress.

But the average man of business is much better able to appreciate the value of research directly applied to the improvement of manufactures than to comprehend the more fundamental importance of pure science. We must show how the investigations of Faraday, pursued for the pure love

[14] SCIENCE, 38, pp. 643–656, 1913.

[15] Lectures before the Royal Institution, 1911.

[16] In 1910 the Nobel prize for chemistry went to Germany for the sixth time, thus giving to a single country sixty per cent. of all the Nobel prizes for chemistry awarded up to that date.

of truth and apparently of no commercial value, nevertheless laid the foundations of electrical engineering. If we can disseminate such knowledge, which is capable of the easiest demonstration and the most striking illustration, we can multiply the friends of pure science and secure new and larger endowments for physics, chemistry and other fundamental subjects.

[While there can be no doubt of the importance of emphasizing the value of industrial research, the necessity of vigilance in the interests of pure science is shown by the opposite tendency of several recent writers, who measure science solely in terms of its applicability in the arts.

The stimulus of commercial rivalry is doubtless a factor in the rapid progress of our great industrial laboratories, but I doubt if their directors would maintain that all chemical research should be of the industrial kind. Immediate commercial value as a criterion of success will not often point the way to the discovery of fundamental laws, though these are by far the richest source of ultimate achievement, practical as well as theoretical. Modern electrical engineers do not forget the investigations of Faraday and Hertz in pure science, nor do leading industrial chemists overlook the researches of Gibbs, van 't Hoff, and others, which brought them no practical returns, but rendered many modern industries possible. Exclusive attention to industrial research means nothing more or less than the growth of the superstructure at the expense of the foundations. Industrial laboratories are able to offer large salaries and other tempting promises of material advantages, and thus to draw the most promising men from the universities. But while these laboratories should be strongly encouraged, and multiplied to the point where every small manufacturer will realize the value of research methods, this should not be done at the serious expense of pure science. Germany's success on the industrial side is primarily due to her still greater achievements in the university laboratories. The National Academy, by helping to maintain the two phases of American research in stable equilibrium, can perform a service which the truest advocates of applied science will recognize as essential to sound progress.]

GEORGE ELLERY HALE
THE MOUNT WILSON
SOLAR OBSERVATORY

(*To be continued*)

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1914, of thirty of the universities of the country will be found tabulated on a following page. These statistics show *only* the registration in the universities considered. There is no intention to convey the idea that these universities are the thirty largest universities in the country, nor that they are necessarily the leading institutions.

The largest gains in terms of student units, including the summer attendance, but making due allowance by deduction for the summer-session students who returned for instruction in the fall, were registered by Columbia (1,365), California (1,109), Pittsburgh (1,069), Ohio State (832), Wisconsin (806), Harvard (784), New York University (634), Minnesota (552), Pennsylvania (536), Illinois (405), Nebraska (349), Cornell (327), Cincinnati (319) and Michigan (311).

Last year there was none that showed a gain of more than 1,000 against four this year, and ten institutions showed gains of more than 300 against fourteen of this year. They were: New York University, Illinois, Columbia, Wisconsin, Pennsylvania, California, Iowa, Ohio State, Chicago and Michigan. There is a theory that universities and colleges have larger increases than usual when national economic conditions are bad, that is during

"hard times." The above seems to bear out this theory.

The only university which shows a decrease in the grand total attendance, including the summer-session, is Indiana. Exclusive of the summer-sessions two other universities show a very slight decrease, Tulane and Kansas.

Omitting the summer-sessions the largest gains for 1914 are Pittsburgh (1,069), Ohio State (687), New York University (580), Pennsylvania (431), Wisconsin (424), California (389), Columbia (349), Minnesota (324), Cincinnati (319), Cornell (318), Illinois (302), Nebraska (297), Harvard (239) and Michigan (218).

Two show gains of more than 900. There were none last year. Fourteen show gains of more than 200 as against twelve last year. Of the fourteen, eight are in the west and six in the east.

According to the figures for 1914, the thirty institutions, inclusive of the summer-sessions, rank as follows: Columbia (11,294), California (8,180), Chicago (7,131), Wisconsin (6,696), Pennsylvania (6,505), Harvard (6,411), Michigan (6,319), New York University (6,142), Cornell (5,939), Illinois (5,664), Ohio State (4,943), Minnesota (4,484), Northwestern (4,072), Syracuse (3,913), Missouri (3,385), Texas (3,371), Yale (3,289), Nebraska (3,199), Pittsburgh (2,975), Iowa (2,768), Kansas (2,650), Tulane (2,441), Cincinnati (2,190), Indiana (2,163), Stanford (1,893), Princeton (1,641), Western Reserve (1,523), John Hopkins (1,374), Washington University (1,345), Virginia (902); whereas last year the order was: Columbia, California, Chicago, Michigan, Pennsylvania, Wisconsin, Harvard, Cornell, New York University, Illinois, Ohio State, Minnesota, Northwestern, Syracuse, Yale, Missouri, Texas, Nebraska, Kansas, Iowa, Tulane, Indiana, Pittsburgh, Cincinnati, Stanford, Princeton, Western Reserve, Johns Hopkins, Washington University and Virginia.

A comparison shows that the following seventeen universities hold the same relative positions (indicated by the numerals following the name) as was held last year. Columbia (1), California (2), Chicago (3), Pennsylvania (5), Illinois (10), Ohio State (11), Minnesota (12), Northwestern (13), Syracuse (14), Nebraska (18), Iowa (20), Stanford (25), Princeton (26), Western Reserve (27), Johns Hopkins (28), Washington University (29) and Virginia (30). On the other hand, there are several changes: Wisconsin comes up to fourth place, passing Michigan and Pennsylvania. Harvard advances one place and Michigan is crowded out of fourth to seventh place. Cornell yields eighth place to New York University. The next change shows Missouri and Texas advancing one place each to fifteenth and sixteenth, respectively, and Yale dropping behind them. Next comes Nebraska and then Pittsburgh, which shows the greatest advance, coming all the way from the twenty-third position to the nineteenth. Iowa holds its own at the twentieth place and is followed by Kansas, which has slipped back two notches. Tulane twenty-second this year, and last year twenty-first, is followed by Cincinnati, which has advanced one place, and then by Indiana, which last year held the twenty-second place. The remaining six schools hold the same places held last year.

If the summer-session enrollment be omitted the universities in the table rank in size as follows: Columbia (6,752), Pennsylvania (5,736), California (5,614), Michigan (5,522), New York University (5,415), Harvard (5,161), Illinois (5,137), Cornell (5,078), Wisconsin (4,874), Ohio State (4,395), Northwestern (3,941), Minnesota (3,940), Chicago (3,887), Syracuse (3,739), Yale (3,289), Pittsburgh (2,975), Nebraska (2,779), Missouri (2,682), Iowa (2,449), Texas (2,447), Kansas (2,304), Cincinnati (2,190), Stanford (1,888), Princeton (1,641), Indiana (1,570), Western Reserve (1,523), Washington University (1,345), Tulane (1,223), Johns Hopkins (1,058), Virginia (902); whereas last year the order was: Columbia, Pennsylvania, Michigan, California, Harvard, Illinois, New York University, Cornell, Wisconsin, Northwestern, Chicago, Ohio State, Syracuse, Minnesota, Yale, Missouri, Nebraska, Texas, Kansas, Iowa, Pittsburgh, Cincinnati, Stanford, Princeton,

Indiana, Western Reserve, Tulane, Washington University, Johns Hopkins and Virginia.

This comparison shows that the relative positions of thirteen of the universities remain unchanged, although only in the case of one institution, Pittsburgh, is the change of more than passing interest. The others shift about as follows: Michigan yields to California, while New York University passes Harvard and Illinois. Northwestern and Chicago now follow Ohio State instead of preceding it as in the past. Minnesota passes Chicago and Syracuse, and the latter is followed by Yale. Pittsburgh leaps to the sixteenth position, passing Missouri, Nebraska, Texas, Kansas and Iowa. Nebraska and Missouri exchange places and Iowa goes ahead of Texas and Kansas. The remaining schools hold the same relative positions with the exception of Washington University and Tulane, which change about.

While on the subject of the change in the relative positions of the universities, based on their registration statistics, it may be of some interest to briefly point out the change in 1914 from the positions held in 1904.

At that time the twenty-seven institutions then considered, inclusive of the summer-session, ranked as follows:

1. Harvard.
2. Columbia.
3. Chicago.
4. Michigan.
5. Minnesota.
6. Cornell.
7. California.
8. Wisconsin.
9. Illinois.
10. Pennsylvania.
11. Yale.
12. Northwestern.
13. Nebraska.
14. Syracuse.
15. New York University.
16. Ohio State.
17. Missouri.
18. Iowa State.
19. Kansas.
20. Stanford.
21. Princeton.
22. Indiana.
23. Tulane.
24. Texas.
25. Western Reserve.
26. Johns Hopkins.
27. Virginia.

Comparing this ranking with that of 1914 shown above, it should be noted that generally speaking the relative positions of the universities have changed but little. By dividing all of the universities considered in 1904 into three equal groups, and by comparing these groups with a similar grouping for 1914, it will be seen that each group has a tendency to hold its membership; in other words, universities in group I. in 1904 are almost certain to be found in group I. in 1914, those in group II. in 1904 are almost certain to be found in group II. in 1914, and those in group III. in 1904 are almost certain to be found in group III. in 1914. There are, however, several exceptions to this rule. Minnesota ten years ago occupied fifth position in group I. and is now occupying twelfth position, or the second position in group II. Pennsylvania headed the second group ten years ago and is now occupying fifth position in the first group. New York University has changed from the fifteenth position to the eighth, that is, from the second group to the first, in the same period. The only other change is that of Texas from the third to the second group.

Changes in the position of the universities within each group are not considerable. Harvard holding the ranking position ten years ago, now has the sixth place, whereas Columbia has taken the lead, with California following. Michigan has gone from the fourth to the seventh position. Yale has dropped from the eleventh to the seventeenth position, and Ohio State has advanced into its place, and Nebraska has dropped back from the thirteenth to the eighteenth position. There are no decided changes in the third group. All of which suggests the conclusion that the increase in attendance of these universities tends to be proportionately equal. This may be discussed more fully in another article.

Including the summer session attendance, the largest gains in the decade from 1904 to 1914 were made by Columbia (6,461), California (4,442), New York University (3,762), Pennsylvania (3,477), Wisconsin (3,326), Ohio State (3,185), Chicago (3,096), Texas (2,441), Michigan (2,319), Illinois (2,295), Cornell (2,106).

Considering, now, the individual schools of the various universities, California with 1,238 men and 1,853 women, leads in the number of college undergraduates, being followed by Harvard, with 2,479 men and 603 women (Radcliffe College); Michigan, with 1,802 men

and 780 women; Wisconsin, with 871 men and 874 women; Columbia, with 1,014 men and 689 women; Chicago, with 911 men and 746 women; Minnesota, with 816 men and 905 women; Texas, with 817 men and 651 women; Yale, with 1,437 men; Kansas, with 776 men and 626 women; Nebraska, with 650 men and 761 women; Missouri, with 829 men and 562 women; Syracuse, with 1,330 men and women; Princeton, with 1,327 men; Indiana, with 778 men and 461 women; Cornell, with 926 men and 279 women, and Northwestern, with 522 men and 653 women. In the scientific schools, that is the schools of engineering, Illinois takes the lead with 1,406 students, followed by Cornell with 1,363, Michigan with 1,347, Yale with 1,056, Pennsylvania with 906, Ohio State with 851, Wisconsin with 796, California with 763, Minnesota with 590, Columbia with 461, Cincinnati with 458, Kansas with 427, and Stanford with 418; and in the law schools Harvard takes the lead with 716 students, followed by New York University with 715, Michigan with 499, Columbia with 440, Pennsylvania with 356, Texas with 343 and Northwestern with 336.

The largest medical school is now in the east at New York University where 439 students are registered in this subject. Michigan follows with 378 students, Johns Hopkins with 374, Columbia with 358, Tulane with 343, Harvard with 321, Pennsylvania with 290, Illinois with 287 and Ohio State with 281. Columbia has the largest non-professional graduate school with 1,689 students, far outnumbering Chicago with 598, Harvard with 512, Pennsylvania with 489, California with 478, New York University with 376, Yale with 371, Illinois with 340 and Cornell and Wisconsin with 321 each. Cornell holds the lead in agriculture with 1,535 students, followed by Wisconsin with 1,091, Ohio State with 973 and Illinois with 959. Four of the universities report courses in architecture. Of these Cornell is the leader with 157 students in this branch, followed by Michigan with 145, Columbia with 110 and California with 16. Harvard, Illinois, Kansas, Minnesota, Ohio State, Pennsylvania, Syracuse, Texas, Tulane and Washington University have registered students in architecture, but listed in other departments. In art Syracuse leads with 150 students and is followed by Washington University. Although courses in art are given at California, Iowa State, Michigan and Northwestern, the students are counted in other departments.

With 2,466 students New York University's School of Commerce is in the lead, numerically speaking; Pennsylvania has the next largest with 1,615 students; following comes Pittsburgh with 790, Northwestern with 645, Wisconsin with 469, Illinois with 376 and California with 287. In this connection it may be of interest to note that the largest school is in the east and that the schools succeed each other in numbers following their geographical location toward the west. In dentistry Pennsylvania holds the lead with 663 students, followed by Northwestern with 578, Michigan with 318 and Iowa State with 302. Of the four divinity schools, Northwestern continues leader with 216 students, as against Chicago's 152, Yale's 112 and Harvard's 59. Syracuse's School of Forestry attracts 242 students this year, Nebraska 43, Yale and Minnesota 37 each. With 136 students in journalism Columbia leads, followed by New York University with 110, Wisconsin with 101, Missouri with 76 and Indiana with 67. Syracuse has 960 music students, and is followed by Northwestern with 400 and Indiana with 100. Columbia has by far the largest school of education, enrolling 1,817 students as compared with Pittsburgh's 668, New York University's 383, Syracuse's 343 and Ohio State's 341. The largest school of pharmacy is at Columbia where 495 students are enrolled. With 200 students Pittsburgh follows and then comes Illinois with 199, Western Reserve with 120 and Michigan with 110. There are only four universities on the list teaching veterinary medicine. These are Ohio State with 182 students, Pennsylvania with 122, Cornell with 116 and New York University with 15.

All of the above figures are for the individual schools and are exclusive of the sum-

mer-session attendance. The largest summer-session in 1914 was at Columbia, where 5,590 students were enrolled, as against 3,983 at Chicago, 3,179 at California, 2,602 at Wisconsin, 1,594 at Michigan, 1,436 at Cornell, 1,250 at Harvard, 1,218 at Tulane and 1,205 at Texas.

Of the 145 students in architecture at the University of California the 16 students listed are graduates only. There are besides 129 who are undergraduates in the college and these are included in the college statistics. In art are registered 213 students but these are included in extension and similar courses. The 936 students in education are included in the college statistics. Forestry and veterinary medicine are included in the School of Agriculture, and music in the College of Liberal Arts. The extension courses show the following registration: San Francisco Institute of Art, 213; Wilmerding School of Industrial Art, 145; University Farm School, Davis, 267; short courses in agriculture, 170; correspondence, 1,996; correspondence work in the state prisons, 153; class work, 538; and class work in state prisons, 608.

Under other courses are listed at the University of Chicago 881 students, all of whom are taking work in regular university classes meeting Saturday morning and late in the afternoon of the other week days. These classes are given primarily for teachers who are working for baccalaureate and for advanced degrees.

At the University of Cincinnati a school of household arts of college grade was opened this year. An advance in entrance requirements to the Medical College has reduced the classes for several years but the turn of the tide has commenced and the entering class this year is larger than that of recent years.

Of the 1,817 students classified under education at Columbia University 921 are in the School of Education and 896 in the School of Practical Arts. The decrease in the number of students in the Schools of Mines, Engineering and Chemistry is caused by the fact that these schools have been placed on a graduate basis. Students are now required to hold a bachelor's degree or the equivalent, including several elementary courses in the sciences.

At Cornell University 534 registered in the winter course in agriculture are listed under extension courses.

The Graduate School of Applied Science at Harvard University is in a state of transition, owing to the cooperative plan with Massachusetts Institute of Technology.

Of the 379 registered in other courses at the University of Illinois, 333 are registered under household science and 46 under library economy.

The total attendance at the University of Iowa, including all departments but excluding the summer-session, is divided into 1,706 men and 797 women.

Of the 374 in the School of Medicine at Johns Hopkins University 361 are registered for the degree of Doctor of Medicine and 13 are taking special courses for physicians. There are 170 students registered in the college courses for teachers given in the afternoons. The department of engineering is only in its third year and all but a small number, that is the third year men, are pursuing courses in the undergraduate college. No record is made this year of the number.

There are 154 students registered in education at the University of Kansas, but all but one of these are listed in other schools of the university.

Of the 1,492 students in the Scientific Schools in the University of Michigan, 1,347 are in engineering and 145 in architecture. The 535 officers include 30 non-resident lecturers and summer-session appointees for the college, 128 graduate assistants, and 23 administrative officials not included elsewhere.

The registrations at the University of Minnesota are incomplete, due to the fact that the short courses, particularly in agriculture, have not been started. These registrations will increase the total mentioned under extension and similar courses.

The figures for the University of Missouri include the enrollment in all schools at Columbia and in the Schools of Mines and Metallurgy at Rollo. The School of Commerce,

which was organized last spring and requires two years of college work for admission, has an enrollment of 12. The decrease in the enrollment of the scientific schools is due to an increase in the admission requirements, since 1911, to two years of college work. Forestry is given in the College of Agriculture.

Of the 282 students in other courses at Northwestern University 110 are enrolled in courses for nurses, and 172 in the School of Oratory. The summer-session in arts was reorganized and the increase the last year was 30 per cent. The Law School is enjoying the largest registration in its history despite the fact that this year the entrance requirements were increased to one year of college work for those twenty years of age and under. The School of Pharmacy has raised its requirements from one year of high school to high school graduation and this increase has cut down the registration from more than 200 in former years to 74 this year. After three years of steady decrease, due to the increase in requirements, the medical school registration shows an increase. The freshman class this year was 83 per cent. larger than that of last year.

Of the 463 men registered in the college of New York University 298 are in the College of Arts and 165 in Washington Square College. The course in journalism is included in the School of Commerce. Under other courses is listed the woman's law class with an enrollment of 50.

This year for the first time the registration statistics of Ohio State University include the enrollment in dentistry and medicine. The latter includes homeopathic medicine. Home economics mentioned under other courses has a registration of 234 and optometrics has a registration of 9.

The University of Pennsyvania, which now enters on its 175th year, shows in the Dental School an enrollment of 663 students, the largest in the history of the school. The School of Education has begun a separate existence with an enrollment of 89, and the Law School shows a decrease of 25. This is the last year for admission to this school without the B.A. degree or its equivalent. The Medical School, which in former years has suffered losses due to the gradual annual increase in the admission requirements, for the first time in seven years shows an increase. There is a slight increase in the department of mechanical and electrical engineering, now separate schools of engineering. The extension courses given at Wilkes-Barre, Scranton, Harrisburg and Reading have a total registration of 564. The Wharton School of Finance enrolls its largest freshman class this year, but, on the other hand, the School of Veterinary Medicine shows a loss because of an increase in the admission requirements to two years of high school work. In the medical and dental departments women have been admitted this year for the first time, three and two respectively being registered. The 743 students in other courses are divided between the college courses for teachers with an enrollment of 727, and courses in hygiene with 16.

The large increase in the University of Pittsburgh is due in part to the improved methods of publicity employed by the university, but mostly to the increase in public interest caused by the general campaign for funds last winter. Of the 304 students in engineering, 226 are registered in the School of Engineering, and 78 in the School of Mines.

Of the 198 students enrolled in other courses at Syracuse University 50 are regular students in architecture, and 63 in *belles lettres*, 20 in photography, and 65 in the School of Oratory. The latter was established last year with a four-year course. The decrease in the College of Law was due to the increase in entrance requirements, which ask now one year of regular college work. Twenty students listed under extension courses took work in the short winter course in agriculture. In connection with New York State College of Forestry of Syracuse University, a forest ranger school is maintained.

The 44 students under other courses at the University of Texas are students in the School for Nurses.

At Tulane University of Louisiana there may be some duplications between the summer-

	California	Chicago	Cincinnati	Columbia	Cornell	Harvard (Inc. Radcliffe)	Illinois	Indiana	Iowa State	Johns Hopkins	Kansas
College, Men	1238	911	247	1014	926	2479	505	778	1358	294	776
College, Women	1853	746	491	689	279	603	426	461		....	626
Scientific Schools*	763	....	458	461	1363	120	1406	295	240	†	427
Law	134	213	....	440	235	716	112	77	191	....	142
Medicine	128	200	80	358	151	321	287	149	144	374	51
Non-professional grad. schools	478	598	138	1689	321	512	340	105	115	230	104
Agriculture	540	....	....	....	1535	....	959	....	....	....	....
Architecture	16	....	....	110	157	†	†	....	....	....	†
Art	†	....	8	....	....	....	....	59	†	....	19
Commerce	287	170	180	....	....	147	376	....	†	....	....
Dentistry	112	....	....	....	....	204	84	....	302	....	....
Divinity	....	152	....	....	....	59	....	....	....	....	....
Forestry	....	....	....	....	....	....	....	....	....	....	....
Journalism	....	....	....	136	....	....	†	67	....	....	....
Music	†	....	....	3	....	....	68	100	....	....	94
Pedagogy	†	262	224	1817	....	....	....	210	†	....	1
Pharmacy	95	....	....	495	....	....	199	....	62	....	64
Veterinary Medicine	....	....	....	....	116	....	....	....	....	....	....
Other Courses	....	881	561	....	....	....	379	8	91	160	....
Deduct Double Registration	30	246	197	460	5	....	4	739	54	....	....
Total	5614	3887	2190	6752	5078	5161	5137	1570	2449	1058	2304
Summer Session 1914	3179	3983	....	5590	1436	1250	938	855	489	356	562
Deduct Double Registration	613	739	....	1048	575	....	411	262	170	40	216
Grand Total 1914	8180	7131	2190	11294	5939	6411	5664	2163	2768	1374	2650
Grand Total 1913	7071	6834	1871	9929	5612	5627	5259	2271	2542	1311	2610
Grand Total 1911	6051	5914	1423	8642	6041	5511	5217	2418	2081	1075	2448
Grand Total 1909	4084	5487	1372	6132	5028	5558	4502	2231	2246	710	2144
Grand Total 1904	3738	4035	767	4833	3833	5392	3369	1206	1460	740	1446
Extension and Similar Courses	4090	....	262	3841	534	10	....	296	....	....	313
Officers	604	....	....	951	....	803	626	125	275	247	....

	Michigan	Minnesota	Missouri	Nebraska	New York University	Northwestern	Ohio State	Pennsylvania	Pittsburgh	Princeton	Stanford	Syracuse	Texas	Tulane	Virginia	Washington University	Western Reserve	Wisconsin	Yale
College, Men	1802	816	829	650	463	522	610	438	411	1327	663	1330	817	162	415	173	434	871	1437
College, Women	780	905	562	761	247	653	389	18	160	....	427		651	197	....	220	416	874	....
Scientific Schools*	1347	590	334	299	261	84	851	906	304	139	418	300	275	149	94	211	....	796	1056
Law	499	171	100	193	715	336	206	356	154	....	177	255	343	83	256	103	96	168	142
Medicine	378	213	75	156	439	196	281	290	107	....	73	99	185	343	107	78	174	96	50
Non-professional grad. schools	258	169	163	190	376	107	165	489	43	175	130	130	75	18	42	45	17	321	371
Agriculture	....	598	536	436	....	....	973	....	....	....	....	101	56	....	....	....	....	1091	....
Architecture	145	†	....	....	....	....	†	†	....	....	....	†	†	†	....	†	....	....	....
Art	†	....	....	67	....	†	....	....	....	....	....	150	....	53	....	142	....	....	38
Commerce	†	....	12	150	2466	645	....	1615	790	....	....	....	74	112	....	....	....	469	....
Dentistry	318	253	....	....	....	578	126	663	227	....	....	....	....	61	....	110	164	....	....
Divinity	....	....	....	....	....	216	....	....	....	....	....	....	....	....	....	....	....	....	112
Forestry	†	37	†	43	†	....	†	....	....	....	....	242	....	....	....	....	....	....	37
Journalism	†	....	76	....	110	....	†	....	....	....	....	....	31	11	....	....	....	101	....
Music	†	†	....	....	....	400	....	32	....	....	....	960	84	16	....	....	....	84	82
Pedagogy	†	94	189	196	383	....	341	89	668	....	....	343	421	85	....	....	....	46	....
Pharmacy	110	97	....	23	....	74	77	....	200	....	....	....	57	8	....	....	120	32	....
Veterinary Medicine	....	....	....	....	15	....	182	122	....	....	....	....	....	....	....	....	....	....	....
Other Courses	....	15	....	....	50	282	243	743	....	....	....	263	44	....	....	308	134	41	....
Deduct Double Registration	115	18	194	385	110	152	49	25	89	....	....	434	666	75	12	45	32	116	36
Total	5522	3940	2682	2779	5415	3941	4395	5736	2975	1641	1888	3739	2447	1223	902	1345	1523	4874	3289
Summer Session 1914	1594	867	956	606	938	245	926	983	....	....	14	296	1205	1218	‡	....	....	2602	....
Deduct Double Registration	797	323	253	186	211	114	392	215	....	....	9	122	281	....	....	....	....	780	....
Grand Total 1914	6319	4484	3385	3199	6142	4072	4943	6504	2975	1641	1893	3913	3371	2441	902	1345	1523	6696	3289
Grand Total 1913	6008	3932	3135	2850	5508	3877	4111	5968	1906	1599	1756	3845	3106	2298	885	1225	1370	5890	3263
Grand Total 1911	5977	4783	2780	2877	4178	3481	3877	5400	....	1543	1684	3408	2669	2128	804	1133	1331	5492	3224
Grand Total 1909	5259	4351	2589	3402	3843	3197	3012	4857	....	1398	1620	3248	2492	1882	767	964	1083	4245	3276
Grand Total 1904	4000	3886	1704	2728	2380	2856	1758	3027	....	1385	1424	2452	930	1124	691	912	808	3370	3008
Extension and Similar Courses	309	830	210	775	1068	110	37	564	212	....	....	20	1072	47	....	....	....	3296	....
Officers	536	....	306	283	450	....	423	....	....	220	349	300	294	339	99	206	255	696	....

* Includes Schools of Mines, Engineering, Chemistry and related subjects. † Included elsewhere. ‡ 1375 with 41 double registrations.

session enrollment and that of the regular term. These, however, were not recorded. The grand total, therefore, may not be comparable with the totals of other universities.

The 211 students in the scientific schools of Washington University are divided between courses in engineering and architecture, while 37 of the students in other courses are enrolled in the department of social economy and the remainder, 271, are enrolled in the Saturday courses for teachers.

Courses for teachers are offered this year in Western Reserve University, and 92 teachers in the public schools of Cleveland are enrolled. There are six students taking one class in the College for Women in connection with work in the Cleveland Art School. These are not included in the statistics.

The non-resident fee of the University of Wisconsin was increased from $70 to $100 a year, taking effect for the first time this fall. Despite this increase the total registration exclusive of the summer-session enrollment is 4,874 as against 4,450 last year.

The Yale University statistics in art do not include 86 enrolled in other departments. Of the 371 in the Graduate School, 89 are taking special teachers' courses. There are 67 students enrolled in other departments not included in the statistics for music. Yale University has no summer-session except for the regular summer work done in connection with certain classes in forestry and engineering. The principal changes in registration from last year are the increase in the College, School of Religion, Law School, and the decrease in the School of Fine Arts and the Sheffield Scientific School. In the School of Fine Arts the decrease is due to the new admission requirements and in the Sheffield School is due partially to the increase in tuition fees.

JOHN C. BURG

NORTHWESTERN UNIVERSITY

CHARLES SEDGWICK MINOT, DECEMBER 23, 1852–NOVEMBER 19, 1914

THE passing of a man like Minot leaves us, his friends, sad and filled with sorrow that so significant a life should be thus swiftly ended. One feels as when he hears of some vanishing form—that just such a creature can hardly come again, for the personality of the unusual man is no less unique and he does not reappear. Yet so long as those who knew Minot live, so long as what he planned and thought persists to mould the purposes of those who follow, so long will his power stretch like the wave that seems to fade but really is extended.

Perhaps Minot was intimate with some men who were his seniors; I doubt not Henry Bowditch was his confidant, but among his contemporaries he seldom showed his thoughts or his emotions in the making. Such intimacies he did not cultivate.

Careful and scrupulous, even in the minor ways of life, the impression which he left was of a man always sensitive to his surroundings—keenly alive to the interests of the greater world, seeing life largely, but ever fastidious and fine in the formulation of the thoughts that occupied his active mind. All life for him was purposeful and very interesting. Few men, upon occasion, could speak more aptly in appreciation of a scientific friend.

Well balanced gifts of a high order, a sound training, stimulating social contacts and ample means were his. As one looks back over the past thirty-five years, Minot is to be found among the first movers in each effort for biological advance: everywhere he took part both with insight and with foresight. The beginnings of the Society of Naturalists—that first effort to bring the working biologists of the newer school together—find him in the van. The American Association for the Advancement of Science, the Marine Biological Laboratory are both indebted to him, and his administration of the Elizabeth Thompson fund remains a model of aid to the efficient.

The honors that belong to such a man came to him generously and steadily yet were always somehow transmuted into public service for the biological world. His European training in the early years included study in the never-to-be-forgotten laboratory of Carl Ludwig, and work with that solitary master, Ran-

vier—great teachers both, who left their impress.

Devoted to the study of structure, he yet maintained, by reason of his early training and the later contacts with Henry Bowditch, a lively interest in the broader problems of physiology; problems which must ever face the serious student of structure. He was first among us systematically to examine the phenomenon of growth after birth, and those who know anything of his history are familiar with the tragedy whereby in a night his whole colony of guinea-pigs, which he had followed in their growth with unremitting care for several years, and which he planned to make the basis of a life-long study, was utterly destroyed. This was a blow that only those who have suffered from some form of sudden and irreparable loss of their labors can appreciate, and it left him for the moment stunned. It was then that he plunged into his embryological work and produced his masterly book on human embryology, accompanying it by the enlargement of that collection of complete series of embryological sections which became so great a feature of his laboratory, and of which he was so justly proud. But the older interest never died, and many who hardly knew the earlier man learned to know him through his last book on "Age, Growth and Death," in which he brought together in his lucid way his work and comments on this fascinating theme.

As a teacher he will long be remembered as the man who made those with eyes to see. Most of us would like our epitaph to run that way; it stands for lasting work.

When we move one side to get the larger view of his activity, it is startling to suddenly recognize that this work of his in histology and embryology—work which started with the beginnings of such things in this country—was conducted in a medical school. I must confess that personally I was always impressed by this. Of course it was as it should be, but how seldom do such things occur. With Minot you were in the realm of pure science, whether you found him in his little dormer room on Bolyston street or in his marble hall of to-day. The technical atmosphere did not enter in; it was always the scientific interest that you felt. Men have worked with him, often I am sure, almost without remembering that his laboratory was counted as part of a professional school. To have achieved such detachment, while doing full justice to those who came to him for professional training only, was a great art, and betokens an unusual man. The teacher of histology to Harvard medical students was a one time president of the American Association for the Advancement of Science, president of the Boston Society of Natural History and recently exchange professor at Berlin. Fortunate the students who had such a teacher, for the qualities of the man went into his instruction.

To dwell upon the man—the man as a force—has been the purpose of these few words, and perchance the better one knew Minot the more the words will mean. At these Christmas meetings, where he was so well known, we shall miss our friend with his clear speech, sure hand in the conduct of affairs and ready, generous interest in each youthful searcher after truth—and we shall remember him.

Henry H. Donaldson

December 19, 1914

SAMUEL FRANKLIN EMMONS MEMORIAL FELLOWSHIP

The friends of the late Dr. Samuel Franklin Emmons have established a fund whose income may be used in support of a fellowship to promote investigations in the branches of geology which were cultivated by him, more especially on the economic side. The funds have been placed in charge of the trustees of Columbia University, but the choice of the fellow and the expenditure of the income are entrusted to a committee consisting of Professors James F. Kemp, John D. Irving and Waldemar Lindgren. The committee announces that it will be prepared to award in March, 1915, a fellowship of $1,000 for the year July 1, 1915 to June 30, 1916, inclusive. Applications must be made on blanks which will be furnished by the secretary of Colum-

bia University, New York, N. Y., and which when filled and accompanied by testimonials and complete statements of the applicant's qualifications will be submitted by him to the committee on March 1, 1915. Applications must be received by the secretary of Columbia University before this date.

The committee requires that applicants should be qualified by proper geological training and experience to undertake the investigation of some problem in or related to economic geology. Each candidate is expected to submit with his application a definite statement of the problem which he proposes to study. The carrying out of the investigation will be under the oversight of the committee and may be undertaken at any place or institution which may be preferred by the holder of the fellowship and which will meet the approval of the committee. The place and publication of results will be decided by the committee. The committee will require that the holder of the fellowship agree to give his entire time and energies to the problem selected, and further agree to contract no other engagements conflicting with or restricting this work without its consent. No objection will be made to the use of the results as a dissertation for the degree of Ph.D. in an approved university.

THE SAN FRANCISCO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

At the meeting of the American Association which will be held in San Francisco and vicinity during the week beginning August 2, 1915, the general appointments of the convocation week will be as follows: The opening session at 10:00 A.M., Monday, August 2, the presidential address and the reception to visiting scientists on Monday evening and four addresses before the association as a whole. The first of these addresses will be given on Tuesday evening by Dr. Fridtjof Nansen, of Norway, upon oceanographic research. On Thursday evening, Professor R. A. Daly, of Harvard University, will present an address upon problems of geologic and biologic interest centering in the Pacific Islands. On Friday evening, Professor W. B. Scott, of Princeton University, will present an address upon the paleontologic relations of North and South America. A final address will be provided for Saturday evening, August 7, upon issues concerning the peoples of the Pacific area.

These general addresses will be given in San Francisco. The section and society meetings will be held on Wednesday, August 5, at Stanford University, and on the remaining days of the week at the University of California in Berkeley.

The geological sessions will be in charge of the Geological Society of America and will be devoted to discussions of erosion and deposition in arid climates, diastrophism of the Pacific coast and petrological problems of the Pacific area. The topics of the meetings of the Paleontological Society include a discussion of the fundamental criteria used in determining the time relations of widely separated life assemblages and rock systems, followed by three symposia upon the special problems encountered in correlation of the Triassic, Cretaceous and Miocene of the Pacific coast with horizons referred to these periods in other parts of the world. Special papers on other topics of interest will be presented.

Zoological sessions are being planned for the discussion of general problems of zoology, evolution and development, of regulation, of geographic distribution, of marine biology, the conservation of wild life, and recent advances in the field of protozoology.

The opening session of the botanical meetings will be devoted to the taxonomy, morphology, history and distribution of Gymnosperms. Subjects discussed at other sessions will be the effects of light upon plants, the geographic distribution of plants with especial reference to the possible origin of the California flora, and marine and fresh-water Algæ.

The subjects of the anthropological meetings will be: Races in the Pacific area with reference to the origin of the American Indians; the history of civilization in the Pacific area, with reference to the relations be-

tween Asia and the New World: and the social aspects of race factors in the Pacific area.

Two general topics will be considered in the agricultural sessions: The relation of agriculture to the food supply of the country, and problems of agricultural conservation. In the treatment of these topics sessions will be devoted to problems of animal production, nutrition, agronomy, soil analysis, general problems of agricultural chemistry and progress in horticultural science.

Papers upon any of these subjects are cordially invited from all members of the American Association and of societies participating in these meetings. Contributions of important work in any other lines of research will also be welcomed and will be included in the programs in so far as time will permit.

SCIENTIFIC NOTES AND NEWS

THE present number of SCIENCE completes the fortieth volume and the twentieth year of the journal under the present editorship. SCIENCE was established in 1883 by Dr. A. Graham Bell and Gardiner G. Hubbard. The president of the board of directors was D. C. Gilman, the vice-president, Simon Newcomb and the editor S. H. Scudder. In 1900 SCIENCE became the official organ of the American Association for the Advancement of Science, and its membership has since increased from 1,721 to over 8,000. The journal has witnessed and to a certain extent assisted the remarkable advance in scientific research which has taken place in America in the course of the past forty years.

AT a joint session of the physiological, biochemical, pharmacological and pathological societies, meeting at St. Louis, on December 28, papers will be presented in memory of S. Weir Mitchell, by Professor Edward T. Reichert, University of Pennsylvania, and of Charles Sedgwick Minot, by Professor Frederic S. Lee, Columbia University.

PROFESSOR EDWARD S. MORSE, director of the Peabody Museum, has been elected president of the Boston Society of Natural History, succeeding the late Professor Charles Sedgwick Minot.

PROFESSOR GEORGE QUINCKE, the distinguished physicist of the University of Heidelberg, has celebrated his eightieth birthday.

DR. JAMES WITHYCOMBE, who was director of the Oregon Agricultural College for nearly fourteen years, will soon enter upon his new duties as governor of Oregon, to which office he was recently elected by an unprecedented majority.

AT the annual meeting of the trustees of the Carnegie Institution of Washington there were elected as trustees Senator Henry Cabot Lodge, of Massachusetts; Dr. George Wharton Pepper, of Philadelphia, formerly professor of law in the University of Pennsylvania; Dr. Theobold Smith, who has resigned the chair of comparative pathology at Harvard University to become a member of the Rockefeller Institute for Medical Research, and Mr. Charles Payne Fenner, of Louisiana. Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, has resigned as a trustee of the Carnegie Institution.

THE statement regarding the award of the Hayden Memorial gold medal by the Academy of Natural Sciences of Philadelphia, in SCIENCE for December 18 requires a correction. After the modification of the deed of trust in 1900, the first gold medal was given to Sir Archibald Geikie, in 1902, the second to Dr. Charles Walcott in 1905, the third to Dr. John Mason Clarke in 1908, and the fourth to Dr. John Casper Branner in 1911.

AT its last meeting, the Rumford Committee of the American Academy made the following appropriations: For the purchase of a refrigerating apparatus for the academy, the same to be loaned to Professor C. A. Kraus for his research on solutions in liquid ammonia, $300. For the purchase of a motor generator for the academy, the same to be loaned to Dr. H. P. Hollnagel for his research on the extreme infra-red portion of the spectrum, $300.

THE National Society for the Promotion of Industrial Education, at its recent meeting at Richmond, has elected the following officers: *President,* William C. Redfield, secretary of commerce; *Vice-president,* Cheesman A. Herrick, president of Girard College;

Philadelphia; *Treasurer*, Frederick B. Pratt, secretary, Pratt Institute, Brooklyn, N. Y.

DR. GEORGE W. CRILE, of the Medical School of Western Reserve University, will leave Cleveland on December 30 for the American Ambulance Hospital, near Paris, to assist in its work.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research, is making a study of the French military medical establishments at the front under the auspices of the government.

DR. ELIE METCHNIKOFF, the eminent Russian pathologist, who for the last twenty-six years has been engaged in research at the Pasteur Institute in Paris, will be seventy years old next year, and a *Festschrift* for him has been in preparation at Paris for this anniversary. The *Journal of the American Medical Association* states that Dr. Emil von Behring, of Marburg, had intended to contribute an article to it, but the breaking out of the war prevented his article reaching the publishers on time, that is before September 1. He now publicly announces (November 12) that he hopes "before the anniversary in question, next May, to manifest in some other way my respect and unwavering friendly sentiments for Metchnikoff on the occasion of his seventieth birthday.

ON December 7, Professor C. J. Keyser, who was a guest of the faculty of Washington University at a smoker held at the Faculty Club of that institution, spoke on the demand for advanced avocational instruction and the obligation of universities to provide it. On the following evening he delivered an address on "Science and Religion" under the auspices of the Washington University Association.

DR. A. G. WORTHING, of the Nela Research Laboratory, Cleveland, addressed a meeting of the physics colloquium of the University of Illinois on December 9, on "Optical Pyrometry and some of Its Applications."

DR. R. RUGGLES GATES, of the University of London, lectured before the Washington University Association, St. Louis, in November, on "The Modern Study of Heredity" and "The Present Status of Evolution."

THE death is announced of Colonel Edward Daniel Meier, past president of the American Society of Mechanical Engineers.

FAYETTE CLAY EWING, JR., associate professor of civil engineering in the University of the South, died suddenly of heart failure at Sewanee, Tenn., on November 28. Mr. Ewing, who was in the twenty-eighth year of his age, was a young engineer and teacher of marked promise. He graduated at the University of Virginia in 1910 with the degree of C.E., and, before going to Sewanee last May, had been connected with railway practise.

ARCHIBALD ROSS COLQUHOUN, the British traveler and explorer, died on December 18, at the age of sixty-six years.

DR. CHARLES PÉRIER, president of the French Academy of Medicine, one of the most distinguished surgeons in France, died on December 13, aged seventy-eight years.

AMONG those killed in the war are: Dr. Alfred Grund, professor of geography in the German University of Prague; Dr. Franz Waterstradt, professor of agriculture in the Agricultural School at Hohenheim; Dr. Fritz Ludwig Kohlrausch, professor for work in radium in the mining school at Freiburg, and Dr. Fricke, professor of forestry in the Forest Academy at Münden.

LARGE bequests for public purposes are made by the will of Mrs. Mary Anna Palmer Draper, to whom in her lifetime science was greatly indebted for intelligent and generous support. Mrs. Draper bequeaths $150,000 to the Harvard College Observatory for the Draper memorial, established in memory of Dr. Henry Draper, her husband, whose photographic plates and apparatus are also bequeathed to the observatory. The sum of $450,000 is given to the New York Public Library, $200,000 for a memorial to Dr. John S. Billings, and $200,000 as a memorial to her father, Courtland Palmer. The income of these funds is to be used for the purchase of books, and an additional trust fund of $50,-

000 is given for the benefit of the employees of the library. There is also a bequest of $25,000 to the Smithsonian Institution; a bequest of objects of art with $20,000 for their care to the Metropolitan Museum; of $50,000 to the New York Polyclinic Hospital; of $25,000 to the New York Skin and Cancer Hospital, and of $25,000 to the laboratory of surgical research of New York University, of whose medical department Dr. Henry Draper was at one time dean.

SECTION L—Education—of the American Association for the Advancement of Science, of which the chairman is Professor Paul H. Hanus, of Harvard University, and the secretary, Stuart A. Courtis, has arranged a two-days' program, that of Wednesday, December 30, being devoted to educational measurement, and that of Thursday, December 21, to the exceptional child. In the mornings there will be presented some thirty ten-minute papers, giving the results of researches on these subjects, and on each afternoon there will be four half-hour addresses. The address of the retiring vice-president and chairman, Dr. P. P. Claxton, U. S. Commissioner of Education, is on the American rural school.

As has already been stated in SCIENCE the American Physiological Society will hold its twenty-seventh annual meeting at St. Louis, Mo., December 27–30. Scientific papers and demonstrations for the meeting have been reported by the following: R. W. Keeton and F. G. Koch; F. S. Lee and C. L. Scott; F. P. Knowlton and A. C. Silvermann; Ida M. Hyde; F. I. Zeman, J. Kohn and P. E. Howe; S. Tashiro; R. S. Pearce; S. Simpson and R. L. Hill; W. L. Gaines; W. B. Cannon, C. A. Binger and R. Litz; C. C. Fowler, M. E. Rehfus and P. B. Hawk; W. H. Spencer, M. E. Rehfus and P. B. Hawk; R. S. Hoskins; H. McGuigan and C. L. v. Hess; W. E. Burge; F. C. MacLean; G. W. Crile, F. W. Hitchings and J. B. Austin; A. L. Beifeld, H. Wheelon and C. R. Lovelette; F. F. Rogers and L. L. Hardt; C. H. Dallwig, A. C. Kolls and A. S. Loevenhart; J. F. McClendon; K. R. Drinker and C. K. Drinker; M. L. Fleisher and L. Loeb; F. S. Lee and D. J. Edwards; B. H. Schlomovitz, J. A. E. Eyster and W. J. Meek; J. A. E. Eyster and W. J. Meek; C. Brooks and A. B. Luckhardt; S. Simpson and A. T. Rasmussen; T. S. Githens and S. J. Meltzer; C. Voegtlin; B. M. Potter; E. G. Martin and P. G. Stiles; M. Dresbach; W. J. Meek and J. A. E. Eyster; E. G. Martin; H. Ginsburg; A. J. Carlson; F. C. Becht and H. McGuigan; H. R. Basinger and A. L. Tatum; C. Voegtlin.

A PRESS dispatch from Denver states that the Federal Commission on Industrial Relations has determined upon an investigation of the country's benevolent organizations. The scope of the investigation is said to be stated by Mr. Frank P. Walsh, chairman of the commission, as follows:

> The commission will investigate the rights, powers and functions of self-perpetuating organizations under their present charters and the extent to which these charters may be stretched under the present Constitution of the United States and the restrictions which present constitutional limitations impose. It will investigate the attitude of high finance toward industrial questions—what organizations such as the Rockefeller Foundation are doing to relieve industrial unrest; how the policies of these organizations are shaped and by whom; what part the source of their income plays in determining what these policies shall be; whether self-perpetuating organizations such as the Rockefeller Foundation are a menace to the future political and economic welfare of the nation; what figure they cut in politics; the labor policy of "Big Business" in general.

A CABLEGRAM to the daily papers says that when the war broke out the Prussian military authorities requisitioned the trained horses of Elberfeld. Dr. Vogel, their owner, protested and the Royal Academy of Berlin supported the protest. A reprieve was granted, but later the horses were requisitioned for an artillery battery and their death on a Flanders battlefield has just been announced. It will be remembered that the "thinking horses" of Elberfeld were first brought to the attention of the public some years ago by their trainer,

Herr K. Krall, who exhibited them at various places in Germany.

In accordance with its usual custom the faculty of medicine of Harvard University will offer a course of free public lectures to be given at the Medical School, on Sunday afternoons, beginning January 3 and ending May 9. The schedule follows:

January 3—Dr. Reid Hunt. Drugs.

January 10—Dr. John Lovett Morse. The care and training of older children.

January 17—Dr. J. L. Goodale. Susceptibility and resistance in diseases of the nose and throat.

January 24—Dr. Alexander Quackenboss. Cataract; its nature and treatment.

January 31.—Dr. William P. Graves. Heredity.

February 7—Dr. S. A. Hopkins. Mouth hygiene as a factor in sickness and health.

February 14—Dr. Harris P. Mosher. Catarrh.

February 21—Dr. George S. Derby. The preservation of the eyesight.

February 28—Dr. Franklin W. White. Food in health and disease. "Food fads." "Health foods." "Vegetarianism."

March 7—Dr. E. G. Martin. Fatigue and rest.

March 14—Dr. F. S. Newell. Modern obstetrics. (To women only.)

March 21—Dr. G. S. C. Badger. Common colds.

March 28—Dr. Percy Brown. The use of X-rays as an aid to our knowledge of disease in the stomach and bowels.

April 4—Dr. R. B. Osgood. The cause and prevention of chronic rheumatism.

April 11—Dr. C. A. Porter. What surgery can do for chronic indigestion.

April 18—Dr. Paul Thorndike. The bladder ailments of man in later life. (To men only.)

April 25—Dr. E. H. Place. What may we do in diminishing the dangers of contagious disease?

May 2—Dr. E. E. Southard. Sex differences in the human brain.

May 9—Dr. W. B. Lancaster. Lighting. Good and bad lighting; its effects on the eyesight.

The *Journal* of the American Medical Association states that the Rockefeller Sanitary Commission which has had in charge the eradication of hookworm in the southern states under the fund of $1,000,000 granted by John D. Rockefeller in 1909, will disband at the close of the present year. The forces of the commission at that time will be withdrawn from all the states in which they have been working except eight, and the work in these will be taken over by the Rockefeller Foundation, a separate organization. The foundation will close up the work in five of the eight states March 1, 1915, and the remaining three on June 30. Under the foundation there has been created an International Commission on Health which will undertake work for the promotion of health in all parts of the world in cooperation with health departments of all countries, and especially will cooperate in the constructive development of state health forces, not alone with reference to hookworm, but in connection with other health conditions.

Another year's laying record of hens bred from selected strains has been compiled by the poultry department of the Oregon station. A flock of fifty hens averaged 213 eggs each during the calendar year, November 1, 1913, to November 1, 1914. If the actual laying year of each hen is counted the average number of eggs laid becomes 220. The world's champion layer, which last year laid 303 eggs in 365 days, has broken the two-year record by the production of 505 eggs in two years, while another hen has averaged more than 200 eggs a year for four years, having laid 819 eggs within that time.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. J. Arthur Beebe has bequeathed $150,000 to the building club of the Harvard Club of Boston; $10,000 to the fund of the Harvard class of 1869, of which class he was a member, though he left before graduation; $10,000 for music at Harvard College, and $5,000 to Dr. F. C. Shattuck for investigations of tropical diseases. The residue of the estate, after some personal bequests have been paid, is bequeathed to Harvard University, the income to be used for the general purposes of the university.

The University of Pennsylvania will be the ultimate beneficiary of the $200,000 estate of William B. Irvine, ex-city treasurer, who died December 6. The money will provide either a building for a school of mining engineering or an auditorium.

THE new building for the Medical College of South Carolina, Charleston, was formally transferred to the board of trustees of the institution, November 18. The address of the occasion was made by Dr. William S. Currell, president of the University of South Carolina.

DR. JOHN HENRY MACCRACKEN, syndic and professor of politics in New York University, has been elected president of Lafayette College. In the same week Dr. Henry Noble MacCracken, professor of English at Smith College, was elected president of Vassar College. They are the sons of Dr. Henry Mitchell MacCracken, chancellor-emeritus of New York University.

PROFESSOR S. F. ACREE, of the Johns Hopkins University, has accepted the position of chief of the Section of Derived Products in the Forest Products Laboratory in Madison and professor of chemistry of forest products in the University of Wisconsin.

MR. DE FOREST HUNGERFORD, instructor in soils in the College of Agriculture, University of Minnesota, has been appointed assistant professor of agronomy in the College of Agriculture, University of Arkansas.

DISCUSSION AND CORRESPONDENCE

RATE OF CONTINENTAL DENUDATION

AT first glance nothing appears more simple than the measurement of the discharge of a large river, and from the volume of matter found to be held in suspension and in solution to calculate the annual depletion of the drainage basin. Ever since the first estimates of Humphreys and Abbot, over half a century ago, the Mississippi River has been a favorite illustration of this kind. Recent results of more elaborate measurements of this character made by the federal government are apparently undertaken with the express purpose of determining the rate of lowering of the continental surface through stream-corrasion.

So soon as a concrete case is settled upon there enters into the problem a number of new and variant factors which, if not perfectly evaluated, utterly invalidate the results sought. In this respect the Mississippi Valley appears to be the most unfortunate choice that it is possible to select. Although the recently published results seem to give excessively small figures and the established rate very much too slow, it is to certain other features that attention is here briefly called, which appear not to have entered into the calculations named.

According to the figures referred to it would take some millions of years to reduce the already low-lying Mississippi basin to the condition of a true peneplain with a position but slightly above tide-level. All direct geologic observations made during late years in the region go to show rather conclusively that in reality the surface of the vast basin is on the whole actually rising instead of becoming notably lower.

Among other factors it appears that the wind-borne dusts from western deserts are alone probably depositing materials over the entire Mississippi Valley faster than the river and its tributaries are carrying rock-waste to the sea. In recent geologic times, also, the western half of the basin has actually had deposits laid down upon its surface to a thickness of not less than 1,000 feet. The great river has not only not been equal to the task of doing its normal amount of work, but it has been so incapacitated as to permit this prodigious volume of rock-waste to accumulate until its original Tertiary surface is already carried far below sea-level. Nowhere on earth is there finer exemplification of vast continental sedimentation.

In the lately compiled estimates of continental lowering several diastrophic factors are left out. These are extremely important in all calculations of this kind. Since Glacial times—perhaps 10,000 years ago—a very considerable part of the upper Mississippi Valley appears to have been elevated not less than 500 to 600 feet. This change of level may represent the isostatic compensation of the last great ice-cap. At any rate, while there has been over this region an erosive loss of a fraction of a foot each century, there has been in the same time a gain in sediments of many times this amount. Growth has exceeded decline a hundred-fold.

The elaborate stream-measurements thus go for naught. They give no clue whatever to the absolute rate of continental lowering through erosion. They merely emphasize the fact of the relative impotency of stream-work in general. They bring into strong contrast the tremendous effects of other geologic agencies of degradation and of aggradation which we have long been accustomed entirely to ignore, or to give only scant consideration.

Charles Keyes

CLADONEMA

In looking up the date for the species of the flagellate protozoon, *Cladonema laxum* Kent 1871 (*Anthophysa laxum* Kent), I found that Seville Kent had proposed for this species the name *Cladonema*,[1] having derived it from the Greek, *klados*, branch, and *nema*, thread. His type species is *C. laxum*, of which he wrote: "This species was first briefly described by the author, with an accompanying figure, in the *Monthly Microscopical Journal* for December, 1871, under the title of *Anthophysa laxa;* the isolated instead of clustered mode of attachment of the animalcules to their pedicle, added to the flexible, thread-like aspect and consistence of their structure, distinguishes it, however, so conspicuously from the representatives of either the genus *Anthophysa* or other allied forms described in this treatise, that a new generic name has been created for its reception," *i. e.*, *Cladonema.*

References to *Cladonema* in the literature earlier than 1880 lead the writer to trace back the name to 1843. In *Ann. des Sci. Nat.* for that year, 11e serie (Zoologie), Tome 20, pp. 370–3, Dujardin listed a new medusa, for which he proposed the name *Cladonema radiatum.* This form had developed from the hydroid *Stauridium* (see description, p. 372). Krohn in 1853[2] accepted the name for the medusa, and only differed from Dujardin's interpretation in minor points in the development into the *Stauridium.* Others to recognize the name *Cladonema* for the medusa prior to 1880 are: Kefferstein und Ehlers, 1861, *Zool. Beitraege,* Neapel, Messina, p. 85, taf. 13, Fig. 5; Van Beneden, 1866, *Mem. Acad. Roy. Belgique,* Tome 36, p. 139, pl. 12; Hincks, 1868, "Hist. Brit. Hydroid. Zooph.," p. 62, pl. 11; Allman, 1872, "Monog. Tubul. Hydroids," pp. 216, 357, pl. 17, Figs. 1–10; and Haeckel, 1879, "Syst. der Medusen," p. 109.

Mayer, in his "Medusa of the World," Pt. I. (Carnegie Inst. Pub.), 1910, recognizes the name *Cladonema* for the medusa form and gives the full bibliography (p. 99). In Pt. III. of this work, p. 719, he writes under the caption "Preoccupied Generic Names":

> The establishment of the Commission upon Zoological Nomenclature and the general recognition which the code that controls its decision has won for itself among naturalists makes it more than ever desirable that the validity of the generic names we now use should be firmly established. Accordingly, the tenability of each and every generic name adopted in this work has been made the subject of thorough research, and I am somewhat surprised to find that names which have been used for generations without question of their priority are actually preoccupied for other groups of animals and can not be applied to the medusæ.

He lists five such cases, *Corynitis, Slabberia, Turris, Tiara* and *Laodicea. Cladonema,* however, remains established for the medusa form.

It seems evident from the above that Kent proposed the name *Cladonema* for the Infusorian without knowing that the name was already occupied. Hence the former name *Anthophysa* Bory, 1822 (?), must be revived for the reception of this species, or a new name proposed.

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Missoula County High School,
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[1] Manual of the Infusoria, Vol. I., London, 1880, pp. 264–65.

[2] *Mueller's Arch. f. Anat. u. Physiol.*, 1853, p. 420.

SCIENTIFIC BOOKS

The British Rust Fungi (Uredinales), their Biology and Classification. By W. B. Grove, M.A. Cambridge, at the University Press. 1913. Pp. xii + 412.

The author of the excellent four-hundred-page volume treating of the British rust fungi has most appropriately begun his preface by reference to the eminent achievements of Plowright embodied in a similar volume twenty-four years previously. Plowright's volume contained a large amount of original matter derived from observation and experiment. In his conception of the *Uredinales* Plowright stood head and shoulders above his English co-workers. He was a leader among British uredinologists.

The volume by Mr. Grove is a worthy successor to Plowright's commanding work. Even if it does not measure up to its prototype in leadership, it can justly be said to present the interesting group of rust fungi, as represented in England and Scotland, in a serviceable and acceptable manner.

In the eighty-four pages devoted to the general part of the work the author has begun by giving in detail the life history of *Puccinia Caricis,* sensibly selecting it instead of the usual *P. graminis* as a typical example of a rust, supplemented by a briefer account of eight other species. Then are successively discussed spore-forms and groupings in accordance with their succession, sexuality including nuclear division, specialization, immunity and phylogeny.

In the larger systematic part of the volume about two hundred and fifty species are described, and nearly all illustrated with original outline drawings. The general plan of the systematic part is modelled after Sydow's "Monographia Uredinearum." The illustrations are superior to those in that work, and approach those of Fischer's "Uredineen der Schweiz," while the method of description is similar to that introduced by the writer in the "North American Flora." Recognition of the diagnostic value of the pores in the urediniospores is especially noteworthy. The technical description is followed by helpful notes for most of the species. Placing that part of the technical description derived from extra-territorial material in brackets promotes clearness and accuracy. The synonymy is said "to show the origin and authority of the name used," as well as to include references to well-known works, the name for each species being selected in accordance with the "principle of priority" as restricted by the International Rules of 1905 and 1910, yet to one who has carefully looked into the history of rust names the result appears to accord more with what one might designate acceptable usage rather than the rigid application of any uniform rules.

If one accepts the conservative standpoint of the author there is nothing of importance in the work that calls for adverse criticism. Both author and publisher are to be commended for the excellence of the volume.

It may be pointed out that in the author's zeal to illustrate with British material a kind of spore which does not occur in connection with any rust in Great Britain, the identical cut which does service as a urediniospore on page 208 is reproduced on page 34 in the general part as an amphispore, although the text says it is only the "nearest approach" to be found among British species. What harm could have come from illustrating a kind of spore not found in Britain by an extra-British example is a mystery to a non-Britisher.

It may also be said that the author has doubtless been led into error by accepting the assignment to the genus *Hemileia* of three species of *Uredo* on orchids. The writer has examined original material on which this assumption is founded, and believes that no teleospores have yet been discovered, those supposed to be such being only oblong urediniospores. The morphology of these rusts, as well as their host relationship, is entirely against their inclusion in the genus *Hemileia.*

Exception must be taken to the author's statement that "the genus *Milesia* is now dropped [for the later *Milesina*], because it was founded on an imperfect state which might belong to any one of several genera." It is true that it was founded on an "imperfect state," if the uredineal sori are to be spoken of as such, but wholly untrue that the spores of this stage are not distinctively characteristic

of the genus. Even the author himself shows the fallacy by his drawings, by a statement at bottom of page 377, by his omission of other spore forms in describing the several species, and in his ability to include a species which had not before been assigned to the genus without having seen other than urediniospores. The attempt to base modern procedure on antiquated and discredited ideas, which this instance well illustrates, accounts for the unfortunate rule of the Brussels Congress throwing out all names for priority not applied to the telial stage. It is this rule which the author is trying to follow.

There is much to be commended in the author's attempt to bring together so-called species which might more properly be considered races or varieties. His nomenclatorial method of using a collective name and description under which constituents are maintained as if autonomous is, however, contrary to De Candolle's fundamental law of nomenclature that a plant can only bear one name of the same grade, a law that has been upheld by every botanical congress since its enunciation in 1813. If *Puccinia Digraphidis, P. Orchidearum-Phalaridis, P. Winteriana* and *P. Phalaridis* are to be grouped as biological races under *Puccinia sessilis,* which seems quite correct, the nomenclature should be adjusted accordingly. We hope with the author that some one may be found with "more knowledge, or more courage," as he says in the preface, to carry this process to other forms.

It requires both more knowledge *and* more courage to advance the lines of classification beyond familiar grounds than most authors are willing to incorporate in their works. To illustrate from the work before us: On pages 73–75 the author technically describes the five families of the order *Uredinales* and gives a key to the twenty-two genera into which the British species may be distributed, using the now generally accepted succession beginning with the fern rusts and ending with *Uromyces* and *Puccinia,* but in the systematic part of the volume the order is reversed to accord with the old and more familiar way. If the makers of manuals will not incorporate what they believe to be the best knowledge available, how can the general student get a working familiarity with it? Too great conservatism is as injurious to the diffusion of substantial information as too pronounced radicalism.

The author deplores the lack of a suitable way to subdivide the genus *Puccinia* with its enormous number of species, "more than 1,300 are already known." After discarding Schröter's and Fischer's classifications because they "separate nearly allied species," he says "Arthur's is a pathless chaos," and decides to arrange the species according to hosts, instead of introducing a "new imperfect scheme." It is evident that the author did not master the classification proposed by the writer, which is founded upon the combination of life histories and morphological characters. That classification can justly be called imperfect, but not artificial, and by no manner of means chaotic. It is imperfect because more information is demanded than was available when it was proposed, and must be emended and changed to accord with knowledge as it comes to hand, as likely to occur in the establishment of a natural system of any group of plants.

The author has not indicated whether the spore-forms which he describes under each species are all the spore-forms belonging to the species, or not, and without such information species can not be distributed in the Arthur system. How to ascertain this important item was pointed out by the writer in 1904. *Puccinia bullata,* for instance, is credited with pycnia, uredinia and telia, but no mention is made of aecia, and *Puccinia Calthae* has pycnia, aecia and telia described, but no uredinia. About one half the species in the book are thus lacking in definite information. It is no wonder the author saw in the Arthur system only "a pathless chaos."

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Textbook on Wireless Telegraphy. By Rupert Stanley, Professor of Physics and Electrical Engineering, Municipal Technical

Institute, Belfast. Longmans, Green & Co. Pp. 344. 201 illustrations. $2.25 net.

It is seldom that a reviewer has the privilege of examining a book which so well accomplishes its purposes as does this elementary text on radio telegraphy. The author states in the preface that his book is designed to fill the needs of those students who, with practically no previous knowledge of electric circuits, desire to become acquainted with the simple theory of wireless telegraphy and with the various pieces of apparatus at present used in radio work. There is surely no text on the market to-day which fills the needs of such students as well as does Professor Stanley's book.

The subject-matter is all useful, live material and is strictly up to date. The historical development of the subject is given only sufficient space to make the student realize the sequence in which the different pieces of apparatus and circuits appeared in the art. Many texts devote a deal of space to detailed descriptions of the early experiments, but this text is fortunately entirely free from such irrelevant material.

The first five chapters deal with general concepts of magnetism and electricity and introduce the reader to the modern idea of the electric current being motion of electrons. Next follows a chapter on measurements and calculations of series and parallel circuits, voltage, current, power, etc. The material of this chapter is well illustrated by problems worked out in the text. Three chapters are devoted to inductance, capacity and oscillatory discharges, with methods of producing them.

Chapter X., on "How Ether Waves are Propagated and Received," deals with a very difficult subject but the author has treated it exceptionally well, bringing into his discussion, day and night effects, effect of water and dry land, etc., and illustrating his explanations by experimental data.

There are six chapters devoted to the various circuits and pieces of apparatus used in sending and receiving stations where the so-called "damped wave system" or spark system is used and one chapter on the generating and receiving apparatus used in systems using continuous waves. A short discussion on miscellaneous apparatus, such as direction finders, amplifiers, galvanometers, hot-wire meters, etc., is followed by the last chapter of the book in which various measurements of radio circuits and apparatus are described.

Four short appendices are devoted to the standard code, call letters of British stations, extracts from international radio regulations and the system of time signals and weather reports sent out from Eiffel Tower. Questions added at the end of each chapter increase the value of the book as a text.

The paper on which the book is printed is not suitable for fine half tones and these are rather disappointing, but to offset this defect the diagrams of circuits and connections are exceptionally well executed. They show thought and skill on the part of the one who designed them. There are minor errors, such as appear in Figs. 38, 43 and 45, but for a first edition the number of errors is very small. The author and publishers deserve much praise from those interested in radio work for putting out this commendable text.

J. H. M.

BOTANICAL NOTES

SOME CORRECTIONS IN REGARD TO TROPICAL LEAVES

DR. SHREVE's paper on "The Direct Effects of Rainfall on Hygrophilous Vegetation"[1] will serve as a corrective for some "casual observation and vivid imagination" in regard to certain adaptational features, in tropical vegetation, especially those pertaining to leaf shapes and structures. His studies were made in the Jamaican forests where the rainfall ranges from 266.7 cm. (100 inches) to 426.7 cm. (170 inches), insuring, with the aid of a generally prevalent fog blanket, an almost continual wetness of the foliage. In these conditions it has generally been assumed that the leaves should have dripping points, velvet surfaces, epiphyllæ and hydathodes. And yet Dr. Shreve found "a very weak representation of such features as the hydathode, the

[1] *Journal of Ecology*, June, 1914.

dripping point, the velvet surface, the variegated leaf, drooping juvenile foliage, etc." Upon some of these structures his comments are suggestive, as,

There is no feature of foliage leaves that appears to give greater promise of having concrete utility under rain-forest conditions than does the hydathode.

Yet in his summary he says:

Plants possessing hydathodes are very infrequent in the montane rain forests of Jamaica.

So, too, he says: "Plants possessing dripping points are relatively uncommon in the rain-forest," and a little later, "Surface wetness does not lower the temperature of leaves sufficiently, under rain-forest conditions, to affect their transpiration rate."

The paper is so full of interesting results that it is quite impossible to summarize it as a whole, yet one rises from reading it with the feeling that it must do much to correct current notions as to the ecology of tropical leaves.

NORTH AMERICAN FLORA

Part 1 of Volume 29 of this slowly moving publication appeared August 31, 1914. It contains the following families of the Order Ericales: *Clethraceae* by N. L. Britton; *Monotropaceae,* by J. K. Small; *Lennoaceae,* by P. A. Rydberg; *Pyrolaceae,* by P. A. Rydberg, and *Ericaceae,* by J. K. Small. In the last-named family the genus *Arctostaphylos,* now named *Uva-ursi,* is treated by LeRoy Abrams.

PERENNIAL GRASS STEMS

In a recent paper on the "Development of the Culms of Grasses" (exclusive of Bamboos) by R. S. Hole, of the Imperial Forest Service of India,[2] is a paragraph which will be of interest to many a botanist:

It is a common belief, probably due to a study of the species characteristic of temperate countries, that the culms of grasses are *annual, i. e.,* that they start growth, attain maturity and ripen grain in a period not exceeding twelve months. In some, at least, of the species of considerable economic importance which are dominant in the Savannah lands of our Indian forests this generalization does not hold good. In *Saccharum munja* Roxb. the culms are, as a rule, biennial, and a number of culms of *Saccharum arundinaceum* Retz. are now under observation in the Dehra Experimental Garden which are two years old and which, although still growing vigorously, have not yet attained maturity.

No doubt other cases of perennial stemmed grasses may be found by a little searching. A woody-stemmed south Florida grass (*Panicum latifolium* L.) appears to have a stem which continues to grow for more than one year.

SOME TEMPERATURE RELATIONS OF PLANTS

Several paragraphs in Dr. Shreve's paper on "The Rôle of Winter Temperatures in Determining the Distribution of Plants"[3] are distinctly quotable, and at the same time helpful to a better understanding of some of the temperature relations of plants. As to phenology and phenologists, he says:

More attention has been given by phenologists to the temperature phases of the growing season, and their potentialities, than to those of the frost season. . . . The gigantic toil of the phenologists between 1850 and 1890 yielded some results on the operation of temperature, and gave us a vast accumulation of data of which some real use was made at the time, and to which we may return in future investigations. . . . Their efforts were handicapped by the fact that they worked extensively rather than intensively, and that they had not a sufficient foundation of physiological facts upon which to operate.

The viewpoint of the geographer—and with him that of many floristic plant geographers—is too broad and general to give due regard to the actual physiological effects of temperature on plants; the point of view of the plant physiologist, on the other hand, is often too intensive to enable him to realize that the "conditions" of his laboratory experiment are identical with the "physical factors" of the environment of plants growing under a state of nature, and he is therefore prone to neglect the bearing of his work on the problems of the field.

From his point of view Dr. Shreve very properly criticizes the system of life zones proposed by Merriam, concluding that

[2] *Forest Bull.* 25, Calcutta, 1914.

[3] *Am. Jour. Bot.,* No. 4, 1914.

in spite of the importance of temperature as a factor in distribution it is illogical to take it as the sole criterion for the limits of distributional regions, especially when the rôle of soil and atmospheric moisture is so obviously of vital importance and is so potent in determining the areas of the principal vegetational regions of the globe.

SHORT NOTES

A YEAR or so ago F. L. Sargent published a helpful little book on applied botany, entitled "Plants and Their Uses" (Holt), and now he adds a helpful 80-page pamphlet of directions to students ("Student's Handbook") to accompany it, and to serve as a laboratory guide.

SOMEWHAT similar in design is Dr. Pool's little book, "Suggestions for Experiments in Plant Physiology" (Univ. Nebr.), consisting of 100 pages. Fifteen illustrations, mostly diagrammatic, supplement the text of very explicit directions.

THE Nature Study Society of Rockford, Ill., has issued a catalogue of "The Trees of Rockford and Vicinity," including 160 species and varieties of native and cultivated trees. Counting the starred names we find that 50 species are natives.

R. A. GORTNER and A. F. Blakeslee show[4] that this very common black mold contains a powerful water-soluble toxin, which is very harmful when injected into different parts of the body of rabbits and guinea-pigs, but apparently not harmful when *fed* to the animals. This paper is presented by the authors as a report of progress.

G. D. FULLER'S "Evaporation and Soil Moisture in Relation to the Succession of Plant Associations"[5] gives some of the results of his studies in the Chicago region. The stations included cottonwood dunes, pine dunes, oak dunes, oak-hickory forests, beech-maple forests and prairies. By graphs and diagrams the results are made evident to the eye.

"A PROVISIONAL List of Parasitic Fungi in Wisconsin,"[6] by J. J. Davis, is a revision of previous lists by Dr. Trelease and J. J. Davis, and brings our knowledge of the parasites of Wisconsin down to date. The list is in two parts, the first being systematic as to the fungi, and the second being an alphabetical list of hosts. In the first there are 61 Phycomycetes; 89 Ascomycetes; 418 Fungi Imperfecti; 339 Uredinales (+ 19 isolated and undetermined forms); 7 Hymenomycetes. The list includes therefore, somewhat more than nine hundred fungi (914 + 19).

OTHER recent short papers are J. F. Clevenger's "Effect of the Soot in Smoke on Vegetation";[7] R. M. Harper's "Coniferous Forests of Eastern North America";[8] J. E. Weaver's "Evaporation and Plant Succession in South Eastern Washington and Adjacent Idaho";[9] Darsie, Elliott and Peirce's "Study of the Germinating Power of Seeds";[10] Babcock's "Studies in Juglans," II.;[11] H. S. Jackson's "New Pomaceous Rust of Economic Importance, *Gymnosporangium blasdaleanum*";[12] Michael Levine's "Origin and Development of the lamellae in *Coprinus micaceous*";[13] and W. A. Cannon's "Specialization in Vegetation and in Environment in California."[14]

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

HADROPTERUS PELTATUS IN THE DELAWARE

SEVERAL interesting local fishes have come to my notice during the past season, the principal of which was a fine large shielded darter, *Hadropterus peltatus*. It was secured in a small pool of rapid water in the course of Skippack Creek, a tributary of the Perkiomen Creek in Montgomery County, on October 24,

4 "Observations on the Toxin of *Rhizopus nigricans*," *Am. Jour. Physiol.*, July, 1914.

5 *Bot. Gaz.*, September, 1914.

6 *Trans. Wis. Acad. Sci.*, October, 1914.

7 Bull. 7, Mellon Institute.

8 *Pop. Sci. Mo.*, October, 1914.

9 *Plant World*, October, 1914.

10 *Bot. Gaz.*, August, 1914.

11 Univ. Calif. Pub., October, 1914.

12 *Phytopathology*, August, 1914.

13 *Am. Jour. Bot.*, July, 1914.

14 *Plant World*, August, 1914.

1914. This is, therefore, the first instance of its occurrence in the basin of the Delaware River, as well as the most eastern and northern locality at which the species has been obtained. The species is of further interest in not having been secured in Pennsylvania since its discovery in the Conestoga in 1864, by Jacob Stauffer. The type, Stauffer's specimen, has been compared in this connection, and agrees in most all respects. It is, however, over three inches in length, though in various works the species is given as of smaller size. Recently Messrs. Radcliffe and Welsh have described a darter from Swan Creek, Maryland, as new, under the name *H. sellaris*. My example differs in having the spinous dorsal more conspicuously lower than the rayed dorsal, one more dorsal spine, naked cheeks and coloration. The additional dorsal spine would appear an intermediate character. *H. sellaris* is shown with the spinous dorsal marked with three dark blotches to each spine, whereas in my example, at present, the dark blotches are only on the membranes. The dark blotches on the back are such as may easily admit of change with age, the Swan Creek specimens being small. Besides the crustaceans *Asellus communis* and *Gammarus fasciatus*, other fishes found in Skippack Creek were *Notropis procne*, *N. whipplii analostanus*, *N. cornutus*, *Rhinichthys atronasus*, *Fundulus diaphanus* and *Boleosoma nigrum olmstedi*. In the brook near Rahn, another Perkiomen tributary, *Semotilus atromaculatus*, *Catostomus commersonnii* and *Micropterus dolomieu* were found, and in Landis Brook near Grater's Ford, besides *Fundulus* and *Rhinichthys*, *Notropis whipplii analostanus* and *Lepomis auritus*.

In the Delaware and its tributaries in Bucks County I met with several species of local interest. One was the *Exoglossum maxillingua* in the river at Morrisville, on July 22, with *Notropis hudsonius amarus*, *N. whipplii analostanus*, *Fundulus heteroclitus macrolepidotus*, *F. diaphanus*, *Lepomis* and *Boleosoma*, showing its association with upper tidal species. In a small tributary above Yardley, *Notropis bifrenatus*, *N. whipplii analostanus*, *N. cornutus*, *Rhinichthys*, *Catostomus* and *Boleosoma* were common. In Taylorville, Knowles and Pidcock's Creeks, *Semotilus atromaculatus*, *Notropis bifrenatus*, *N. whipplii analostanus*, *N. cornutus*, *Rhinichthys*, *Fundulus diaphanus*, *Lepomis* and *Boleosoma* were about equally abundant. *Pimephales notatus* and *Semotilus bullaris* were peculiar to Taylorville Creek, while *Hybognathus nuchalis regius* and *Esox americanus* were only found in Knowles, and *Catostomus* occurred in both. This is the first instance of *Pimephales* in this section, though I have it from further west, or the Schuylkill. *Rhinichthys* was the only fish found in Cutaloosa Creek. In Brock Creek near Roelofs, *Esox americanus*, *Notropis cornutus*, *Erimyzon sucetta oblongus* and *Boleosoma* were found, the last two also occurring in isolated pools in the course of Common Creek near Fallsington, associated with *Notropis bifrenatus*, *Aphredoderus sayanus* and *Enneacanthus gloriosus*. The last species was also met with in the creek near the village of Penn's Manor, with *Abramis crysoleucas*, *Ameiurus nebulosus*, *Schilbeodes gyrinus*, *Fundulus diaphanus*, *Apeltes quadracus*, *Lepomis auritus* and *Eupomotis gibbosus*. In Chester County, in the various headwaters of the White Clay Creek, near Londongrove, only *Salvelinus fontinalis*, *Rhinichthys* and *Boleosoma* were met with abundantly.

HENRY W. FOWLER
ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA,
October 31, 1914

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Philadelphia, during convocation week, beginning on December 28, 1914:

American Association for the Advancement of Science.—**President, Dr. Charles W. Eliot, Harvard University; retiring president, Professor Edmund B. Wilson, Columbia University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary,**

Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.; secretary of the council, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.

Section A—Mathematics and Astronomy.—Vice-president, Professor Henry S. White, Vassar College; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Anthony Zeleny, University of Minnesota; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Provost Edgar F. Smith, University of Pennsylvania; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Albert Noble, New York; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor U. S. Grant, Northwestern University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor Frank R. Lillie, University of Chicago; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Dr. G. P. Clinton, Connecticut Agricultural Experiment Station; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Dr. Clark Wissler, American Museum of Natural History; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Richard Mills Pearce, University of Pennsylvania; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Professor Paul H. Hanus, Harvard University; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor L. H. Bailey, Cornell University; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

The American Physical Society.—Convocation Week. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 29. President, Professor C. R. Mann, Carnegie Foundation, New York City; secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 31. President, Professor Samuel F. Clarke, Williams College; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 29–31. President, Professor C. E. McClung, University of Pennsylvania; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Society of American Bacteriologists.—December 29–31. President, Professor Charles E. Marshall, Massachusetts Agricultural College; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

The Entomological Society of America.—December 31–January 1. President, Professor Philip P. Calvert, University of Pennsylvania; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 28–31. President, Professor H. T. Fernald, Amherst College; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Geological Society of America.—December 29–31. President, Dr. George F. Becker, U. S. Geological Survey, Washington, D. C.; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Paleontological Society.—December 29–31. President, Dr. Henry F. Osborn, American Museum of Natural History, New York City; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Botanical Society of America.—December 29–January 1. President, Dr. A. S. Hitchcock, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 29–January 1. President, Dr. Haven Metcalf, U. S. Department of Agriculture; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Fern Society.—December 28–29. Secretary, Charles A. Weatherby, 749 Main St., East Hartford, Conn.

Sullivant Moss Society.—December 30. Secretary, Edward B. Chamberlain, 18 West 89th St., New York, N. Y.

American Nature-Study Society.—December 30–31. Secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Alpine Club.—January 2. Secretary, Howard Palmer, New London, Conn.

American Association of Official Horticultural Inspectors.—December 29–30. Chairman, Dr. W. E. Britton, New Haven; secretary, Professor J. G. Saunders, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Charles Brookover, Little Rock, Ark.; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

The American Anthropological Association.—December 28–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Psychological Association.—December 30–January 1. President, Professor R. S. Woodworth, Columbia University; secretary, Professor R. M. Ogden, University of Tennessee, Nashville, Tenn.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The American Association for Labor Legislation.—December 28–29. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

Society of Sigma XI.—December 29. President, Professor J. McKeen Cattell, Columbia University; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

ST. LOUIS

The American Physiological Society.—December 28–30. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor Graham Lusk, Cornell University Medical School; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 28–30. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

The American Society for Experimental Pathology.—December 28–30. President, Professor Richard M. Pearce, University of Pennsylvania; secretary, Dr. George L. Whipple, San Francisco, Cal.

CHICAGO

American Mathematical Society.—December 28–29. President, Professor E. B. Van Vleck, University of Wisconsin.

The Association of American Geographers.—December 29–31. President, Professor A. P. Brigham, Colgate University; secretary, Professor Isaiah Bowman, Yale University, New Haven, Conn.

The American Philosophical Association.—December 28–30. President, Professor J. H. Tufts, University of Chicago; secretary, Professor E. G. Spaulding, Princeton, N. J.

PRINCETON

The American Economic Association.—December 28–31. President, Professor John D. Gray, University of Minnesota; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW YORK CITY

The American Mathematical Society.—January 1–2. President, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th St., New York City.